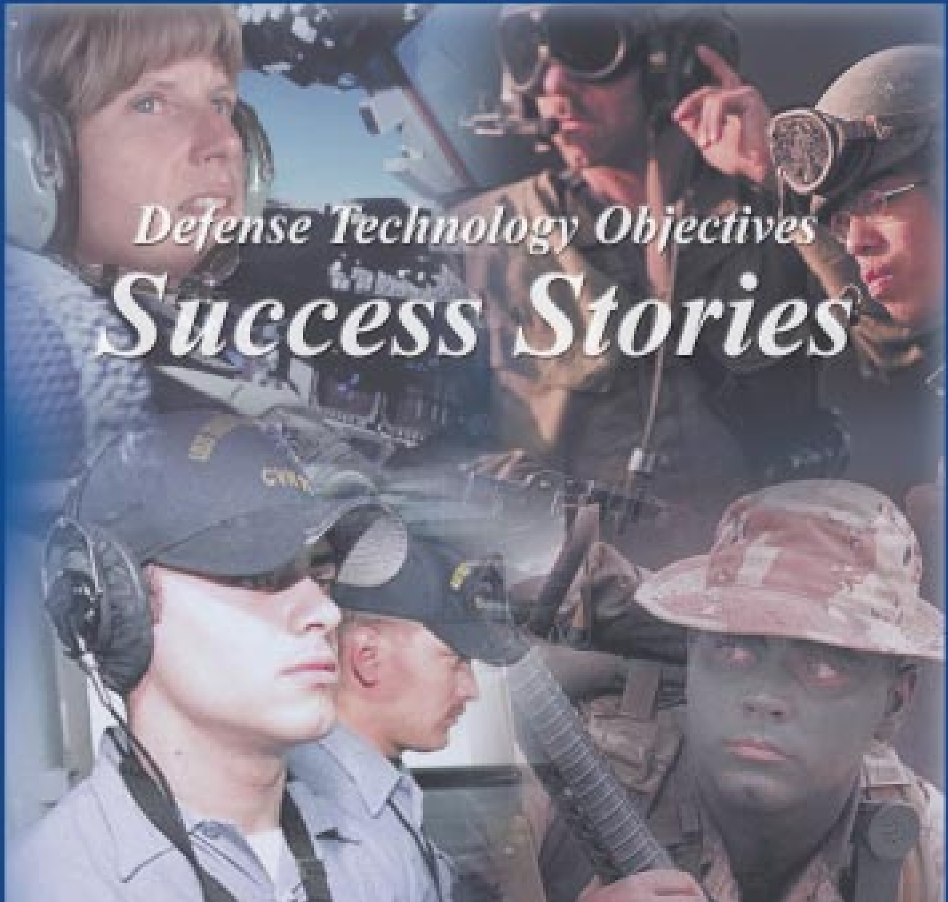
Defense Science and Technology
RELIANCE



March 2001

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. REPORT DATE (DD-MM-YYYY) 01-03-2001	2. REPORT TYPE	3. DATES COVERED (FROM - TO) xx-xx-2001 to xx-xx-2001

4. TITLE AND SUBTITLE Defense Science and Technology RELIANCE--Defense Technology Objectives Success Stories Unclassified	5a. CONTRACT NUMBER 5b. GRANT NUMBER 5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER 5e. TASK NUMBER 5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Defense Deputy Under Secretary of Defense (Science and Technology) Washington, DCxxxxx	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME AND ADDRESS ,	10. SPONSOR/MONITOR'S ACRONYM(S) 11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
APUBLIC RELEASE
,

13. SUPPLEMENTARY NOTES
See Also ADM001269

14. ABSTRACT
See report.

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19. NAME OF RESPONSIBLE PERSON
			Public Release	115	EM154, (blank) lfenster@dtic.mil
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER International Area Code Area Code Telephone Number 703767-9007 DSN 427-9007

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39.18

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LETTER FROM DR. DELORES M. ETTER

March 2001

The Department of Defense maintains a strong science and technology (S&T) program to provide options for responding to a full range of military challenges, both today and into the uncertain future. Technological superiority has been, and continues to be, one of the foundations of our national military strategy. It is through the Department's investment in S&T that we develop the technology foundation necessary for the Department's modernization effort, discover new technologies that produce revolutionary capabilities, and provide a hedge against future uncertainty. Tomorrow's military capabilities depend in part on today's investment in enabling technologies that can be integrated into new or existing systems and employed using new operational concepts.

Maintaining our technological edge has become even more important as the size of our armed forces has decreased and advanced technology has become readily available on the world market. It is the mission of the Defense S&T program to ensure that our warfighters today and tomorrow have superior and affordable technology to support their missions and provide revolutionary capabilities.

This document highlights some of the recent accomplishments the Department's S&T program has made through the completion of Defense Technology Objectives (DTOs). DTOs are the building blocks of the Defense Technology Area Plan and the Joint Warfighting Science and Technology Plan. This document catalogues the completions of DTOs from 1997 to the present. Each DTO represents the achievement of a specific objective to ensure that our armed forces have the technology base required for the development of future critical capabilities.

Delores M. Etter

Deputy Under Secretary of Defense
(Science & Technology)

INTRODUCTION

The mission of the Department of Defense (DoD) Science and Technology (S&T) Program is to ensure that United States warfighters have superior and affordable technology to support their missions and to provide revolutionary capabilities. The Department's S&T investment is focused through Defense Technology Objectives (DTOs), which have become the building blocks of the Defense S&T program. DTOs are Service and Defense Agency coordinated technology programs planned under the aegis of the Defense S&T Reliance process. These programs are successfully completed on a regular basis. Completed DTOs not only address the perennial obsolescence of military technology, they also contribute to extending the capabilities of the U.S. warfighter, and they do so at less overall cost due to Defense S&T Reliance efforts to combine resources and reduce redundancy. This document contains quantitative and qualitative descriptions of DTOs that have been successfully completed since 1997. For a complete listing of all ongoing DTOs, please refer to Appendix A.

Initiated during the closing years of the Cold War, when shrinking defense budgets forced a reevaluation of the way business was being done, Defense S&T Reliance now comprises the three Services, the Ballistic Missile Defense Organization (BMDO), the Defense Threat Reduction Agency (DTRA), the Defense Advanced Research Projects Agency (DARPA), the Office of the Deputy Under Secretary of Defense for Advanced Systems and Concepts (ODUSD(AS&C)), and the Joint Staff (J-8). Each participant cooperates with the ultimate goal of retaining or extending the technological edge that allows the U.S. to prevail decisively across the full spectrum of conflict.

The DoD S&T program is guided by five principal documents, the goals of which are to better focus our collective efforts on superior joint warfare capabilities and improving interoperability between the U.S. and our Allies. These documents, as well as the supporting individual S&T master plans of the military Services and Defense Agencies, guide the annual preparation of the DoD budget and program objective memorandums (POMs).

The Defense S&T Strategy responds to the vision of developing and transitioning superior technology to enable affordable, decisive military capability across the full spectrum of crises and challenges of an uncertain future. S&T investment areas that have high priority in making strategic decisions are information assurance, battlespace awareness, force protection, reducing cost of ownership, and maintaining basic research

The *Basic Research Plan* (BRP) presents the DoD objectives and investment strategy for DoD-sponsored Basic Research (6.1) performed by universities, industry, and Service laboratories. In addition, it presents the planned investment in each of 10 technical disciplines composing the Defense basic research plan.

The *Defense Technology Area Plan* (DTAP) presents the DoD objectives and the Applied Research (6.2) and Advanced Technology Development (6.3) investment strategy for technologies critical to DoD acquisition plans, Service warfighter capabilities, and the *Joint Warfighting Science and Technology Plan* (JWSTP). It takes a horizontal perspective across the Service and Defense Agency efforts, thereby charting the total DoD investment for a given technology. The DTAP documents the focus, content, and principal objectives of the overall DoD science and technology efforts.

The JWSTP also takes a joint perspective horizontally across the Applied Research (6.2) and Advanced Technology Development (6.3) plans of the Services and Defense Agencies, but for a different purpose. Its objective is to ensure that the S&T Program supports priority future joint warfighting capabilities. The Joint Requirements Oversight Council (JROC) has endorsed the JWSTP planning process and methodology and the Joint Warfighting Capability Objectives (JWCOs) used in the development of the JWSTP. The 12 JWCOs are not all inclusive- there are other important joint and service-unique warfighting and operations-other-than-war capabilities that need strong S&T support. Nevertheless, the JWCOs provide an important focus for the S&T Program.

The coupling of the DTAP and the JWSTP is carried out in several ways. First, the planning stage of the 12 technical areas of the DTAP has the active participation of the Service laboratories, the Defense Agencies, and the warfighters (through the operating commands, such as the Army's Training and Doctrine Command [TRADOC]). This activity takes place by providing requirements and, sometimes, serving on planning committees that focus on or include basic research. Second, representatives of the Service laboratories and operating commands also take part in the program evaluation process through attendance and participation in Service S&T Program reviews and the Deputy Under Secretary of Defense (S&T) Technology Area Reviews and Assessments (TARAs).

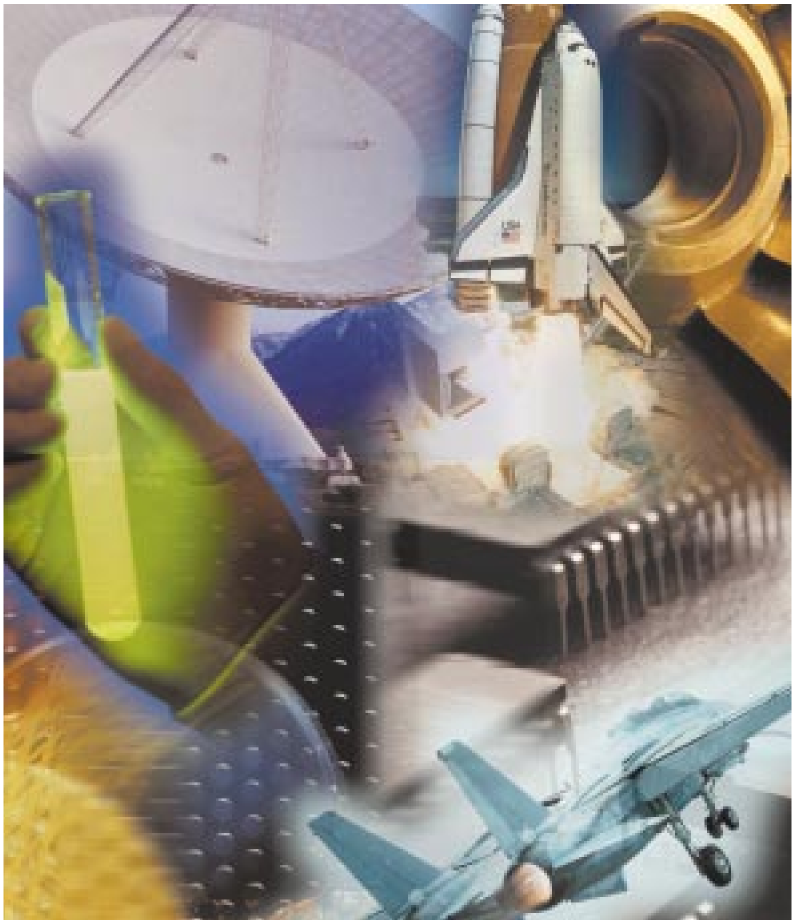
Together, the JWSTP and DTAP ensure that the near- and mid-term needs of the joint warfighter are properly balanced and supported in the S&T planning, programming, budgeting, and assessment activities of DoD. The BRP supports the far-term research needs of the DoD.

DTOs focus and guide S&T investment planning. Each DTO identifies a specific technology advancement that is needed to be developed and demonstrated, the anticipated date of technology availability, the specific benefits resulting from the technology advance, and the associated funding needed to achieve the new capability. These benefits not only include increased military operational capabilities but also address other important areas, including affordability and dual-use applications.

The successful completion of each DTO represents a step towards realizing the capabilities needed for the warfighter and envisioned in these S&T documents, as well as in *Joint Vision 2020* and the other seminal documents that guide the Department's vision of the future environment. The achievement of these objectives will support acquiring the capabilities the U.S. warfighter will need to defeat any adversary in the foreseeable future, and to allow the U.S. to remain the preeminent military power in the world.

This brochure is organized into two sections, with two supporting appendices. The first section contains DTOs associated with the DTAP, while the second section contains DTOs associated with the JWSTP. Appendix A contains telephone numbers and/or email addresses of individuals who can provide additional information on the completed DTOs described in this document. Appendix B is a list of all ongoing DTOs.

DEFENSE TECHNOLOGY AREA PLAN



COMPLETED DTOs

The Air Platforms technology area includes efforts devoted to piloted and unmanned air vehicles. The five subareas are fixed-wing vehicles, rotary-wing vehicles, integrated high-performance turbine engine technology (IHPTET), high-speed propulsion and fuels, and aircraft power. The fixed-wing vehicle subarea includes technology efforts in aerodynamics, flight control, structures, subsystems, and integration (including flight demonstration). It does not include aircraft propulsion, power, human systems, avionics, weapons, materials, or manufacturing technology developments, but does consider the overall integration of these disciplines with the airframe. Similarly, the rotary-wing vehicle subarea includes technology efforts in aeromechanics, flight control, drive systems, structures, and subsystems and excludes the same disciplines that are excluded from the fixed-wing subarea. IHPTET includes technology efforts in compression systems, combustion systems, turbine systems, exhaust systems, controls and accessories, and mechanical systems, as well as full-scale demonstrations. The aircraft power subarea includes technology efforts in power generation, power distribution, energy storage, and system integration. The high-speed propulsion and fuels subarea includes technology efforts in air-induction systems, combustors/ramburners, nozzle/expansion systems, fuels and fuel systems, and structures and materials.

Air Platforms technology interfaces with other technology areas impacting air vehicle system capability, including Information Systems Technology; Materials/Processes; Sensors, Electronics, and Electronic Warfare; Human Systems; and Weapons.

ADVANCED AERODYNAMIC CONCEPTS FOR INCREASED FLIGHT EFFICIENCY (AP.01)

Background. The Advanced Aerodynamic Concepts for Increased Flight Efficiency DTO completed a number of significant projects in the areas of advanced configurations, active flow control, aero-propulsion integration, aero-weapon integration, and applied computational fluid dynamics.

Success. The Active Core Exhaust C-17 program successfully developed and demonstrated a system that mixes cooler air with the hot exhaust gas of an engine. This allows more affordable, lower temperature materials to be used on parts of the aircraft structure where the exhaust impinges. The redesigned Active Core Exhaust Control engine nozzle resulted in a 22% reduction in nozzle weight.

An Autonomous Ground Collision Avoidance System (Auto-GCAS) was developed and demonstrated jointly with the Swedish Ministry of Defense (MoD). This system is being transitioned to the JAS-39 Gripen and the F-16. Auto-GCAS provides an automatic, last-ditch maneuver to avoid impacting the ground and will prevent Controlled Flight Into Terrain accidents.

Advanced Compact Inlet technology was developed and demonstrated to permit the use of serpentine inlet ducts. Serpentine ducts allow the engine compressor face to be hidden for improved aircraft low observability, but creates engine airflow challenges.

Flow Control technologies were developed that keep the airflow smooth and consistent at the compressor face. In addition, improved inlet design and analysis techniques were developed that permit lighter-weight engine inlets to be built that can still meet engine hammershock requirements. This resulted in a 50% reduction in engine inlet weight that was demonstrated and transitioned to the Joint Strike Fighter (JSF) program. A thrust vectoring system was developed for aircraft that does not require the entire nozzle to rotate or translate, demonstrating a potential 4% weight savings for an air vehicle with thrust vectoring.

Flow control techniques were also applied to the problem of weapon carriage and separation from an internal bay. Several designs were tested in wind tunnels and flight tested on F-111 aircraft in cooperation with the Australian MoD. These technologies are critical for the F-22 and JSF, which must use internal weapon bays for stealthiness. Wind tunnel tests were performed on innovative air vehicle configurations designed to drastically improve aerodynamic performance. An 8% increase in landing configuration lift coefficient was realized.

Finally, the in-house development of a full Navier-Stokes flow solver was completed: the result is Cobalt60. This Computational Fluid Dynamics (CFD) tool is the first to efficiently use unstructured grids to reduce CFD grid generation time from days to hours. In addition, Cobalt60 uses parallel computing to further reduce run time by 200%. Cobalt60 has been applied to the F-18 wing drop problem, Joint Direct Attack Munition (JDAM) weapon separation, V-22 shipboard operations, the Space Maneuvering Vehicle, and many other DoD air and space vehicles. Cobalt60 has gained widespread industry and academic acceptance.

Completed. 2000

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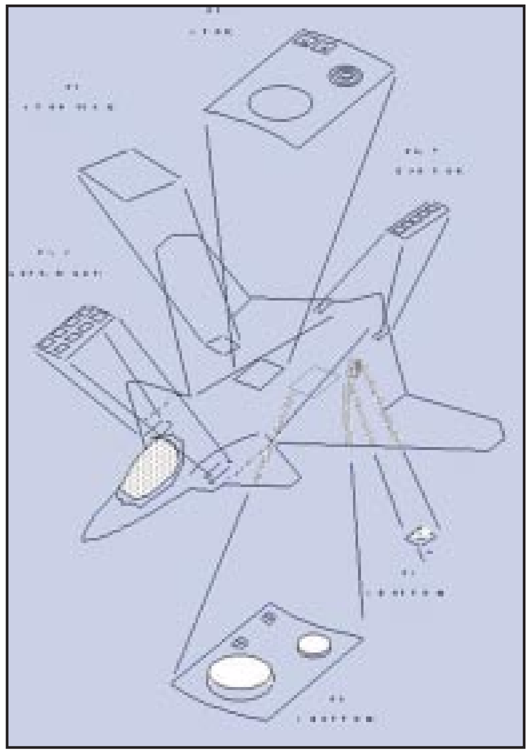
FIXED-WING VEHICLE STRUCTURE TECHNOLOGY (AP.02)

Background. The cost- and weight-reduction potentials of more unitized structure has been demonstrated through the design, manufacture, and test of a large, bonded-wing component based on V-22 wing requirements. Adhesive-bonded joints for composite structure have been shown to be durable and damage tolerant. Although other technologies demonstrated in this program are not yet fully mature for transition, the predicted benefits include up to 40% cost reduction versus a baseline V-22 wing.



Success. Technology developed during this program has been applied to the Bell 609 Tiltrotor aircraft, and is being considered for application to the V-22 wing. Predicted savings are on the order of $500,000 per wing, varying depending on number of aircraft affected. Z-pins can be used to replace mechanical fasteners and provide 50–80% cost savings and 5–10% weight savings. Z-pins can also be used to increase the durability and damage tolerance of laminated composite structures to reduce operation and support costs. Z-pin composite joining and reinforcing technology has been transitioned to F-18 E/F for qualification testing.

Skin panel and tail end-cap conformal loadbearing antenna structures (CLAS) technology has been demonstrated. A skin panel concept is now under consideration for transition to the AFSOC C-130 fleet to replace the APR-46 omni-directional antennas. CLAS technology features radio frequency antennas embedded in the skin of air vehicle structures. CLAS provides 25–50% cost and weight savings over conventional nonloadbearing antenna installations. CLAS enables elimination of blade and other protruding antennas, reducing drag between 0.3% and 2.0%. Together these benefits extend range or increase payload. CLAS allows larger apertures, providing such increases in avionics performance as a 17-fold increase for VHF radio range for vertical tail end-cap, which will allow future radio equipment to be smaller and lighter, to consume less power, and to produce less heat requiring dissipation.

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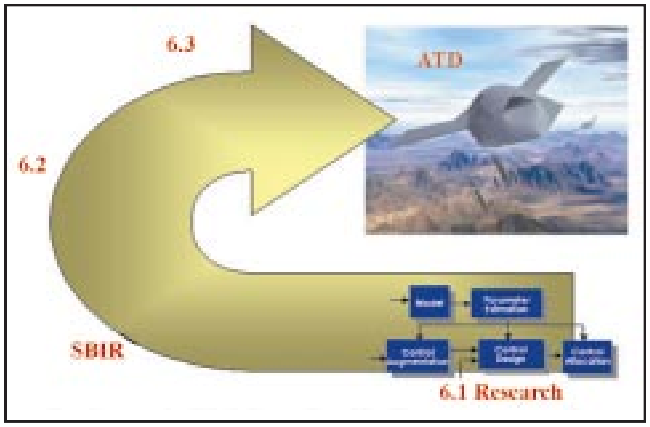
FLIGHT CONTROL TECHNOLOGY FOR AFFORDABLE GLOBAL REACH/POWER (AP.04)



Background. The RESTORE (Reconfigurable Control for Tailless Fighter Aircraft) was the first in-flight demonstration of an adaptive reconfigurable neural network flight control that enables a pilot to safety fly the aircraft after critical control failures that would normally result in loss of control. Unlike traditional reconfiguration methods, RESTORE control laws compensate for unknown and unanticipated damage and actuator failures by continuously adapting to the changing dynamical behavior of the aircraft. Although it was demonstrated on a tailless fighter configuration, this technology is applicable to both conventional military and commercial aircraft configurations.

Success. The Air Force Research Laboratory (AFRL) and the Naval Air Systems Command jointly sponsored the X-36 flight tests used to demonstrate RESTORE technology. The X-36 vehicle provided an excellent demonstration platform because it was a scale model of a tailless fighter aircraft with a flight control system that provided redundant, multi-axis conventional control surfaces, split flaps, and yaw thrust vectoring, thus providing reconfiguration capability for simulating control surface failures.

RESTORE control laws provide cost-efficient architectures that are designed to update the control laws in real time on board the aircraft, providing tolerance to actuator failures and battle damage. The RESTORE modular control law architecture will reduce development costs and encourage technology insertion. It is possible to retrofit this technology into existing flight control systems, as demonstrated by the X-36 flight tests. Another advantage of this emerging technology is that it is readily transferable to other digital flight control aircraft vehicles, including those in the private sector. RESTORE flight control algorithms would significantly improve commercial aviation safety by providing on-board reconfiguration capabilities.

This technology has been used in the development of a control system for NASA's X-33 Reusable Launch Vehicle program. Additionally, the RESTORE control architecture was a baseline flight control system for the DARPA/AFRL/Boeing Unmanned Combat Air Vehicle (UCAV), scheduled for flight demonstration in 2001.

Completed. 2000

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MATURITY DEMONSTRATION OF ADVANCED AIR PLATFORM TECHNOLOGY (AP.05)

Background. The UCAV Program is a joint DARPA/U.S. Air Force (USAF) Advanced Technology Demonstration (ATD) program to demonstrate the technical feasibility of a UCAV system to effectively and affordably prosecute twenty-first century Suppression of Enemy Air Defenses (SEAD)/Strike missions within the emerging global command and control architecture. The Air Force is committed to an aggressive program of exploiting unmanned air vehicle (UAV) technology for SEAD in the mid-term and movement into a broader range of combat missions depending on technology maturation, affordability, and migration to other forms of warfare. The joint DARPA/USAF UCAV ATD provided the information necessary to enable decisionmakers to determine whether it is technically and fiscally prudent to continue development of a UCAV system to perform the SEAD/Strike mission. Ongoing studies are addressing the mix of manned and unmanned systems. Those studies will further refine the optimum numbers, cost effectiveness, and timeline to meet the future needs of the Air Force. The knowledge gained from the ATD will be a key input to defining the best force mix for the post-2010 timeframe.

Success. DARPA and AFRL initiated Phase I of the DARPA/USAF UCAV ATD in 1998. Three contractors performed extensive analyses on the feasibility of addressing the SEAD role with UAVs. Concepts of operations (CONOPS), mission objectives, technologies, and capabilities were explored in depth. Air vehicle concepts that took advantage of the removal of the pilot from the aircraft were developed. The command, control, intelligence, surveillance, and reconnaissance (C2ISR) architecture was analyzed to determine the best mix of on-board versus off-board sensing. Operator-vehicle interface was examined to maximize the number of vehicles a single operator can control. Supportability concepts were addressed to maximize storage and deployment capability and minimize life-cycle cost.

The analyses concluded that the combat UAV of most value would be larger than a cruise missile, but smaller than an F-16. The detailed cost analyses confirmed that an acquisition cost less than one-third of that of the JSF is achievable. The operations and support cost will be less than 25% of that of the F-16 Harm Targeting System.

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COMPONENT AND STRUCTURAL ASSESSMENT RESEARCH (CAESAR) ENGINE (AP.09)

Background. The Component and Structural Assessment Research (CAESAR) Engine was a joint effort between the AFRL Propulsion Directorate, F-22 System Program Office, JSF program office, Pratt & Whitney Aircraft, General Electric Aircraft Engines, Allison Advanced Development Company, and Rolls Royce. The goal of this program was to demonstrate advanced technologies that can transition to future advanced fighter engines. This included the successful demonstration of the durability capabilities of those technologies.

Success. The demonstrated advanced technologies developed under the IHPTET included supercooled turbine blades and vanes, gTiAl compressor blades (four contractors blades), and advanced brush seals. Also demonstrated was the ability to successfully manufacture several exhaust case elements. The engine completed 1,505 accelerated mission test (AMT) total accumulated cycles (TAC), 335 hours of AMT time, and 6.9 hours of augmentor time. The technologies that were demonstrated would lead to a potential engine weight reduction of 115 pounds, engine cost avoidance of $100,000, and reduction of specific fuel consumption for the F-22 greater than 1%. In addition, technology transition plans have recently been signed for both the JSF/F-119 and JSF/F-120 engine programs based in part on the success of the CAESAR engine test program.

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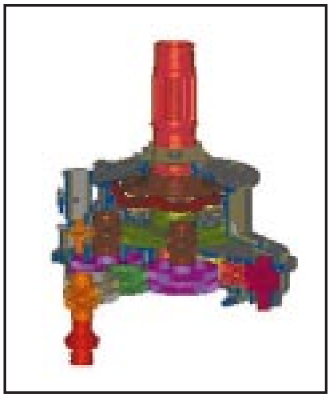
ADVANCED ROTORCRAFT TRANSMISSION II (ART II) (AP.12)

Background. The Advanced Rotocraft Transmission II (ART II) program objectives were to design, fabricate, and test an advanced technology rotorcraft transmission with 25% increased shaft horsepower-to-weight, 10 dB reduction in drive train generated noise, 2x increase in reliability, and 10% reduction in acquisition cost. The ART II objectives are relative to modern production rotorcraft such as the AH-64 A/D, UH-60L, and V-22. The program consisted of detailed design, fabrication, and extensive development and demonstration testing in a representative environment.



Success. Achieving the program weight, noise, reliability, and cost goals requires the integration of advanced materials, components, and manufacturing techniques into a complete system. The ART II design utilized a modern technology main gearbox as a baseline. It retained the same engine, proprotor and pylon drive shaft locations and geometry in order to use existing test stands. Reduction ratio, speed, and power were also maintained. The primary technologies utilized included positive engagement type clutch; low-noise double helical gears in the input, idler, and first and second reduction stages; use of a torque-splitting first reduction stage that allowed elimination of the high speed planetary, hybrid ceramic bearings with PEEK cages instead of all-steel bearings; high-temperature ,corrosion-resistant magnesium housings instead of aluminum; a high-contact ratio planetary with precision-forged gears versus a standard planetary; and a hot-running lube system.

Development and demonstration testing included rig testing of the overrunning clutch, 50 hours of endurance testing, and a 200-hour overstress test. Results of the testing confirmed the design predictions and verified achievement of the power-to-weight, noise, durability, and cost goals.

The technology demonstrated in ART II is available for upgrades to current fleet rotorcraft such as UH-60, AH-64, CH-47, RAH-66, and V-22. It will also provide a technology foundation for the further improvements required for the Future Transport Rotorcraft. Many of the individual component and manufacturing techniques are now available within the vendor base and thus are accessible for new and upgraded designs.

The demonstration and subsequent application of the ART II technology will provide the warfighter with rotorcraft that have greater range and payload capability. For a typical AH-64 attack mission, ART II would provide +19% range or +29% payload. These benefits are based upon a 14,292-lbs. gross weight and a 222-km mission radius. This level of performance increase is key to meeting the Army's visions for more responsive, agile, lethal, and sustainable forward-deployed forces. The improved durability of the drive system will result in increased availability of the aircraft and greatly reduced support costs. The increased payload for the AH-64 translates to increased firepower though the ability to carry additional missiles and 20-mm rounds. The reduction in internal noise levels will yield a significant reduction in long-term hearing loss for the crew. It will also reduce fatigue and increase communications of crew and passengers who are exposed to the excessive noise levels continuously for several hours.

Completed. 2000

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IMPROVED JP-8 FUEL (AP.18)

Background. JP-8+100 is an improved JP-8 fuel with increased thermal stability. The overall goal is to increase the maximum temperature capability of JP-8 from 325°F to 425°F, hence the name "JP-8+100." Higher thermal stability equates to reduced fuel system maintenance in current aircraft systems and increased fuel heat sink capability for new or upgraded systems. Cost and logistics considerations drove the selection of additives to JP-8 as the approach to improving the fuel's thermal stability, instead of examining more expensive specialty fuels. JP-8+100 is created by adding roughly 250 parts per million (ppm) of an additive mixture to JP-8, at a current cost of $0.005/gallon. The additive package consists of a dispersant, an antioxidant, and a metal deactivator. The additive was developed by soliciting candidates from industry (about 400 received to date), which were then screened in a series of in-house test rigs, before being transitioned to engine and flight tests. AFRL/PRSF is currently assessing further candidates to improve the number of additive sources and to keep costs low.

Success. JP-8+100 has been transitioned to almost 3,000 Air Force aircraft (Air Combat Command [ACC], Air Education and Training Command [AETC], and Air Mobility Command[AMC]), and has achieved over 1,000,000 hours of operation. Base-level demonstrations have measured significant maintenance cost reductions ($170/flight hour in two cases). JP-8+100 has also been transitioned to law enforcement helicopter fleets in Florida and NATO ally Denmark, and is being flight tested by the commercial airline KLM. JP-8+100 won the General Yates award for technology transfer in 1999. The program also produced new dispersant-tolerant fuel-water separation technology, improving the quality of fuel (both JP-8 and JP-8+100) delivered to aircraft by reducing dirt and water. The technology produced in the JP-8+100 program is being transitioned to Air Force units by SA-ALC/SF.

Completed. 2000

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The Chemical/Biological (CB) Defense technology area is devoted to the development of technology to counter the threat of CB weapons and to ensure the safety and mission effectiveness of U.S. forces operating within a contaminated environment with minimal impact on logistics.

This technology area is divided into medical and nonmedical CB defense program areas, with six subareas.

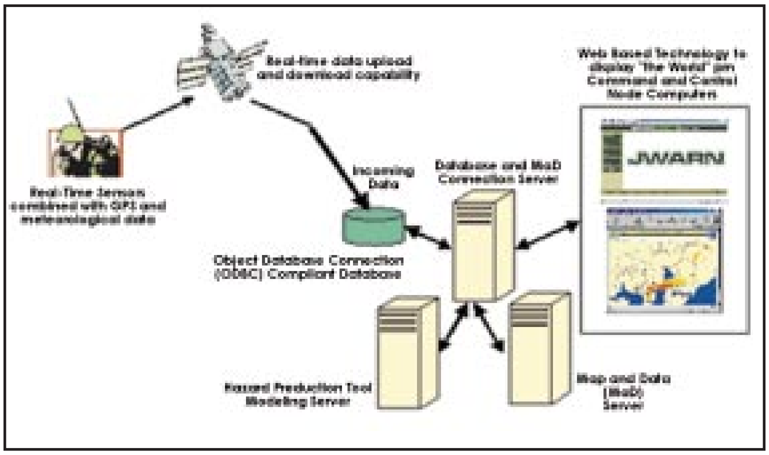
The Reliance goal in CB defense is the seamless integration of technologies from its six subareas – detection, protection, medical chemical defense, medical biological defense, decontamination, and modeling and simulation – into a system of systems that can be horizontally integrated across the spectrum of combat and support systems.

Additional information can also be found in the Chapter XII of the JWSTP.

CHEMICAL/BIOLOGICAL DEFENSE

JOINT WARNING AND REPORTING NETWORK (CB.02)

Background. This DTO demonstrated technology to support the Joint Warning and Reporting Network (JWARN) P3I objective system that will seamlessly integrate into the Global Command and Control System (GCCS) or any other command and control (C2) node that complies with Defense Information Infrastructure/Common Operating Environment (DII/COE). This effort included integrating technologies associated with warning and reporting software, object-oriented databases, Hazard Prediction Tools (HPTs), web-based capabilities, and sensors to enhance situation awareness and management for a 2005-2010 timeframe.



Success. In FY99, a tradeoff analysis was completed. Parameters were a cost target of $300 per unit, data transmission rates of 120, 300, 384, 600, 960, 1,920, 154,400, 308,800, and 1,544,000 bits per second. This capability, with the ability to link up to 10,000 sensors, was demonstrated using a chemical sensor, a biological sensor, and a nuclear sensor. In addition to near–real-time displayed information, a CB hazard area projection was demonstrated through a linked HPT. This technology provides automated, near-real-time capability that links sensor data into the GCCS or any DII/COE-compliant C2 node to enhance situational awareness on multiple command levels and assist commander decision-making. Information, dependent on need, can be displayed at different levels of complexity, from a single sensor to all sensors in the battlefield. Near-real-time data can be integrated with other C2-available data (meteorological, geographical, intelligence, etc.) to provide an HPT-generated display of time-lapsed predictions of hazard areas permitting commanders to formulate strategic plans. Comparing current with projected 2007 capabilities, this technology will evolve to be cost effective, have high data handling capabilities (up to a factor of five enhancement above current), be modular in design for rapid upgrading, and provide information at greater speeds and detail. This effort identified future policy issues in the areas of command, control, communications, computers, information, intelligence (C4I2).

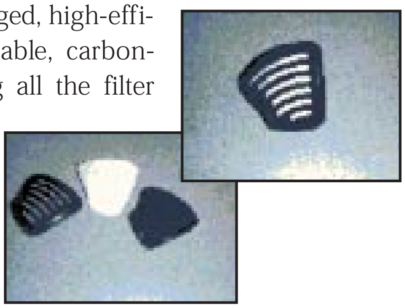
Completed. 1999

SPONSORS

DoD Chemical and Biological Defense Program

ENHANCED RESPIRATOR FILTRATION TECHNOLOGY (CB.16)

Background. The Enhanced Respirator Filtration Technology DTO exploited the latest filter technologies, including low-resistance, electrostatically charged, high-efficiency particulate aerosol (HEPA) quality media and flexible, moldable, carbon-absorbent structures, to develop a filter system capable of meeting all the filter requirements of the Joint Service General-Purpose Mask (JSGPM).



Success. The Enhanced Respirator Filtration Technology DTO was initiated in FY96. Major accomplishments in FY96 included the development and evaluation of a bonded-carbon sorbent and the identification and preliminary screening of candidate low-resistance, HEPA-quality, electrostatic filtration media. In addition, an in-house test capability for assessing particulate filter media performance was established, and a mold was designed and fabricated to produce a contoured filter bed for the JSGPM design concept. In FY97, baseline screening of candidate electrostatic filtration media was completed and the most promising candidate selected. New filter technologies resulted in a filter that provides full protection with reduced breathing resistance and lower profile. The filter has transitioned to the JSGPM program.

Completed. 1998

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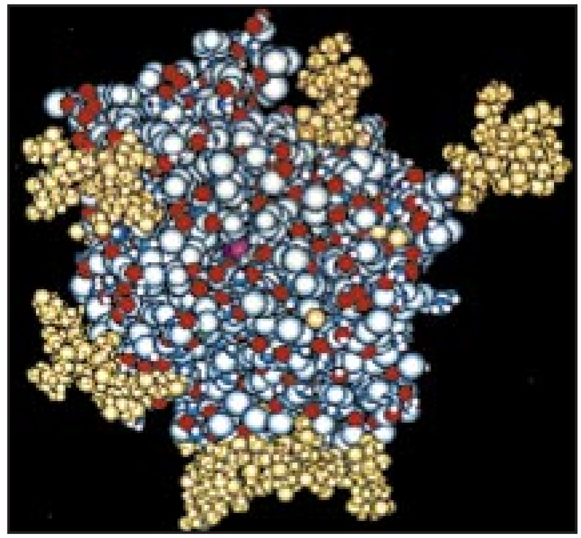
DoD Chemical and Biological Defense Program

CHEMICAL AGENT PROPHYLAXES (CB.21)



Background. This DTO demonstrated proof-of-concept for an improved medical protection capability against the threat of nerve agents.

Success. The specific technology to be developed through this effort is a circulating scavenger, e.g., genetically engineered human cholinesterase, for use as a prophylactic/pretreatment for nerve agent exposure. Protein-based bioscavengers were identified that protect against 5 LD50s of nerve agent in animal models without additional therapy and without significant physiological or psychological side effects. These capabilities were transitioned to the concept exploration phase (Phase 0). In comparison to currently fielded nerve agent countermeasures, achievement of this technology objective provides a capability for extended protection against a wide spectrum of nerve agents without causing side effects, behavioral effects, or the need for extensive post-exposure therapy. Nerve agent prophylaxis would proactively protect the warfighter against nerve agent exposure. This capability would also deter the use of chemical warfare agents by an enemy and increase the capability of U. S. forces and allies to sustain operational tempo and provide full-dimension protection.

Completed. 1999

SPONSORS

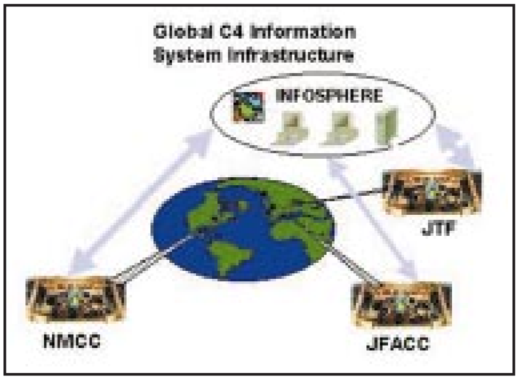
DoD Chemical and Biological Defense Program

The DTAP for Information Systems Technology (IST) covers the five subareas listed below. Because of the high degree of interrelationship among the five IST subareas, the technology development efforts for them are being integrated to achieve greater focus and efficiency from our technologies and provide a common framework for integrating new ones as they emerge.

- **Decision-making** is the heart of the command and control process. It encompasses the development of common, modular elements that connect joint mission planning, rehearsal, execution monitoring, and common pictures of the battlespace. This subarea provides battlefield visualization and situational assessment products that support real-time operations.
- **Modeling and Simulation** (M&S) is a fundamental component of the other four IST subareas. M&S also supports all other DTAP areas and JWCOs contained in the JWSTP. M&S technologies provide the means for continuous, predictive planning; an assessment capability for supporting the development of other technologies; and interoperability support between simulations and live command, control, communications, computers and intelligence (C4I) systems. Cost-effective development of an M&S application is achieved through the use of a common technical framework for M&S (e.g., high-level architecture, Conceptual Model of the Mission Space, and data standardization) along with authoritative representations of environments, systems, weapons effects, and human behavior.
- **Information Assurance** provides the warfighter with the means to protect information systems and the means to ensure continued information superiority in the face of the full range of potential computer network attacks. The technologies developed address 1) the ability to protect DoD information, systems, and networks from attack 2) the capability to detect information warfare attacks in real time and 3) the ability to react quickly to ensure mission critical information is available, correct, and secure.
- **Seamless Communications** spans the globe, interconnecting command echelons, services, and allies worldwide. It develops the technologies to assure a warfighter's access to all forms of information for any type of mission whenever and wherever needed. Focus is on antennas, networking technologies, network management, and wireless technology developments.
- **Computing and Software Technology** develops the core technologies and systems foundations needed to provide warfighters with the capability to collect, process, and disseminate an uninterrupted flow of information to achieve information superiority. Focus is on autonomous software, intelligent information management and interaction, and advanced software technology..

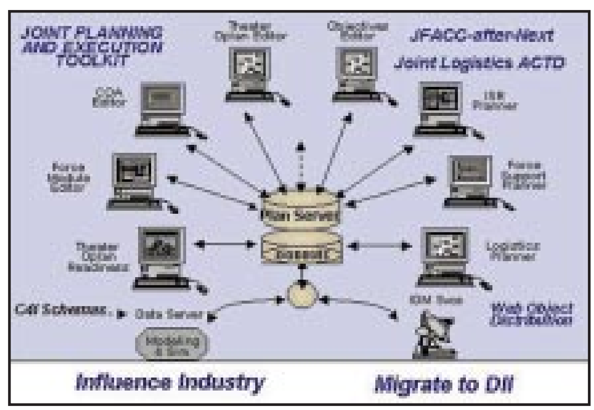
INFORMATION SYSTEMS TECHNOLOGY

ASSURED DISTRIBUTED ENVIRONMENT SUPPORT (IS.15)



Background. The objective of the Assured Distributed Environment Support DTO was to develop and demonstrate a globally distributed, heterogeneous information infrastructure to provide warfighters at all echelons with immediate and location-transparent access to information.

Success. Technology barriers that were overcome included development of distributed computing environments with system state management, dynamic reconfigurability, and scalability over widely disparate communications backbones, heterogeneous systems, and multiple clusters or domains. It used a combination of government-off-the-shelf (GOTS), commercial-off-the-shelf (COTS), and standards to demonstrate and exemplify the targeted systems capabilities. The earliest investigations included a pre-CORBA (Common Object Request Broker Architecture) distributed computing environment called CRONUS, used primarily by the Air Force and Navy. This prototype was used to focus on military critical capabilities (survivability, robustness, and load balancing) needed from the developing CORBA international standard. In time, CRONUS was restructured to become the first GOTS CORBA software package, named CORBUS. CORBUS has shown communications agility by being demonstrated over multiple military and commercial communications backbones. This DTO has led to other developments such as the Joint Task Force ATD's development of the Next Generation Information Infrastructure (NGII), the CORBA Real Time specification, and developing CORBA Fault Tolerance specification. The major transitions have been to standards bodies such as the Object Management Group that develops the specifications for CORBA. Industry has responded to CORBA with a wide array of COTS products, providing the government with a wide industrial base. The major payoff to the military is that it can now procure distributed systems from industry using commercial products and standards with military critical capabilities. The added combat capability for the warfighter includes robust and timely collaboration with CONUS and reachback to information bases. The use of COTS and the intellectual base derived from within this DTO have become the cornerstone for military critical distributed computing systems.



Completed. 1999

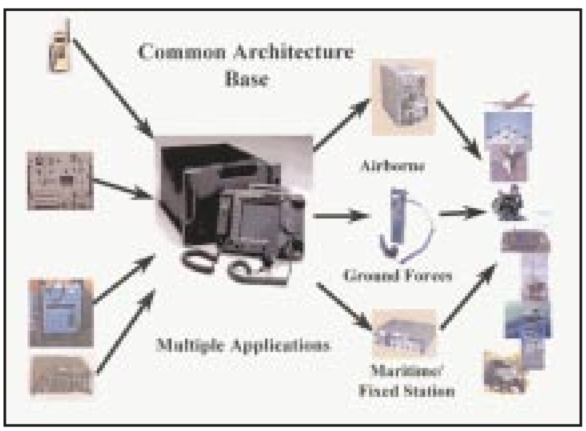
SPONSORS

Navy
Air Force

MULTIMODE, MULTIBAND INFORMATION SYSTEM (IS.24)

Background. The Multimode, Multiband Information System was developed to be the technical foundation for the next-generation warfighter communications architecture for future digital radio and integrated avionics suites.

Success. The primary achievements of this DTO came from the multiservice program known as SPEAKeasy. It demonstrated multiband operation and bridging of voice circuits during JWTD-94. The Army's Communications and Electronics Command (CECOM) Research and Development Center (RDEC) managed design studies for wideband/multiband antennas. SPEAKeasy resulted in a fully programmable open-system design that was field tested in 1997 at the Army Task Force XXI Advanced Warfighting Experiment. AFRL, DARPA, and CECOM facilitated the formation of the Modular Multifunction Information Transfer System Forum, which grew to include numerous international participants, commercial wireless developers, service providers, and regulators. It has since evolved into a not-for-profit corporation that is world renowned. In 1993, the Future Multiband Multiwaveform Modular Tactical Radio (FM3TR) was started and placed under the Air Force's Long Term Technology program, a four-power initiative with the United States, the United Kingdom, France, and Germany. In 1998, the FM^{3}TR program conducted the first demonstration between two international software programmable radios. The four-power group has focused on future efforts to host new waveforms on various platforms. The Joint Tactical Radio System (JTRS) Program Office will effect the transition of this technology into the service acquisition agencies.



Completed. 1999

SPONSORS

Army
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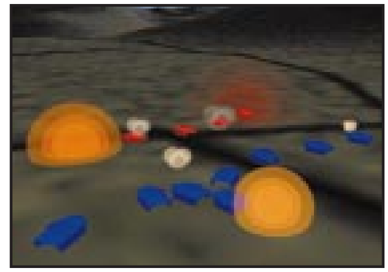
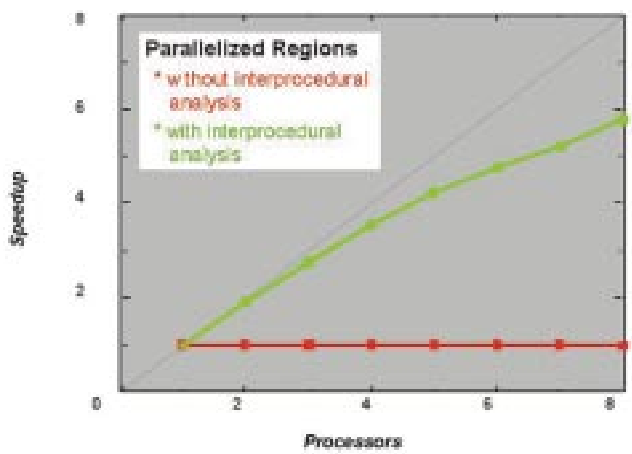
SOFTWARE TECHNOLOGY FOR HIGH-PERFORMANCE COMPUTING (IS.29)



Background. The objective of the Software Technology for High-Performance Computing DTO was to develop and demonstrate software tools, languages, and algorithms to enable the cost-effective application of high-performance (HP) computers to new domains such as modeling and simulation. This DTO addressed the development of architecture-independent scalable software libraries, HP languages, and runtime services that enable parallelization and efficient communication.

Success. At the 1998 TARA review, this DTO demonstrated the largest distributed battlefield simulation ever. A record-breaking 100,298 vehicles were simulated on thirteen parallel computers comprising 1,386 processors through the use of the CalTech/Space and Naval Warfare Systems Command (SPAWAR)-developed Synthetic Forces Express (SFE) simulation engine. SFE incorporates a scalable communications architecture based on interest management to significantly reduce message traffic. Prior to this work, a 100,000-vehicle simulation capability had not been envisioned until 2002. Rice University developed an advanced prototype High-Performance Fortran (HPF) compiler, called dHPF, that was used to automatically parallelize NASA's Numerical Aeronautical Simulation (NAS) benchmarks, achieving execution times within 0–21% of highly optimized, hand-coded versions of NAS Code transformations. The techniques have doubled the performance of MAGI, an Air Force particle hydrodynamics code. An electromagnetics scattering code for predicting radar cross sections (RCS) scalable to massively parallel computers was developed by Boeing. The code, ParaDym, scales linearly on massively parallel machines and permits RCS prediction for important targets with fine geometric detail. Several widely used engineering codes critical to the development of defense systems have been parallelized and are now commercially available, including a parallel version of MSC/NASTRAN, the most widely used finite-element code for stress analysis, and the Parallel Spectrum Solver, the first parallel commercial-grade software for multi-physics simulation.



Completed. 1999

SPONSORS

Air Force
DARPA

The Ground and Sea Vehicles technology area addresses platform and system technologies that support ground vehicles (land combat and tactical vehicles and amphibious vehicles with a ground combat role) and sea vehicles (surface ship combatants and submarines). For ground vehicles, this includes intravehicle digitization, propulsion and power, track and suspension, chassis and turret structures, vehicle subsystems, hydrodynamics, integrated survivability, fuels and lubricants, and integration technologies. For surface ship combatants and submarines, this includes structural systems, maneuvering and seakeeping, power and automation, and signature control. The subareas covered by this technology area are ground vehicles, surface ship combatants, and submarines.

GROUND/SEA VEHICLES

GROUND VEHICLE CHASSIS AND TURRET TECHNOLOGIES (GV.05)

Background. This DTO advanced the design and manufacture of large, integrated composite structural components that meet ground vehicle affordability, producibility, and supportability requirements. The DTO demonstrated the capability for the use of composite structural components allowing vehicles with light and medium ballistic threat requirements to reduce their Gross Vehicle Weights (GVW) by 10–18%.

Success. The result is the significant reduction of vehicle GVW resulting in improved deployability, increased payloads (including survivability enhancements), increased growth potential, and reduced logistics burdens. Coordination was done with the U.S. Marine Corps on lightweight materials and land mine survivability work for ground vehicles. A variation of the Composite Armored Vehicle (CAV) ATD laminate has been integrated into the Crusader Demonstration/Validation (DV) vehicle designs. The Program Manager (PM) Crusader considers CAV as a major success, as the composite armor allowed for the reduction of system weight, while maintaining required protection levels. Hardware is being produced and integrated into the DV vehicle testing. The CAV ATD itself has completed 3,000 miles of durability testing, automotive performance testing, signature testing, and 105-mm gun forces testing. The customers for this DTO are PM Crusader and the U.S. Army Field Artillery School.

Completed. 1998

SPONSORS

Army

The Materials/Processes technology area addresses DoD needs in hardware, platform, and infrastructure development and production. This technology area encompasses the four broad foundational technologies listed below. These four subareas pursue developments in Air Platforms; Ground and Sea Vehicles; Chemical/Biological Defense; Nuclear Technologies; Sensors, Electronics, and Electronic Warfare; Battlespace Environment; and Weapons. The Materials/Processes area also includes the development of pollution prevention technologies and adaptations to manufacturing, refurbishment, and disposal processes associated with DoD hardware and platforms to make them comply with federal environmental law, and contributes to the quality of the environment through resource conservation and remediation. The four foundational technologies link research and development production, concerns about undesirable manufacturing byproducts, deployment to the field, environmental quality, and performance.

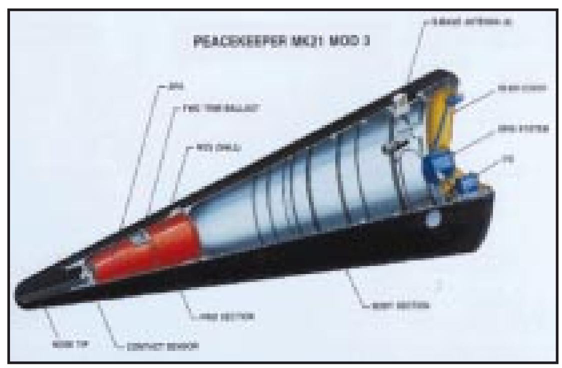
- **Materials and Processes for Survivability, Life Extension, and Affordability.** Provides enabling materials technologies to ensure the survival of the individual combatant and equipment, ensure maximum effectiveness of the force via understanding of the operational situation, and maximize the ability of the force to neutralize hostile threats. Develops 1) environmentally benign materials such as new corrosion-resistant alloys, coatings, and lubricants, and 2) processes such as corrosion control, fatigue analysis, nondestructive evaluation, and condition-based maintenance. Both significantly extend the lives of current and new defense assets and address environmental regulatory goals. Furnishes basic materials on which new and upgraded platforms will rely for increased performance, survivability, and longevity at affordable costs.
- **Manufacturing Technology (ManTech).** Supports force modernization and readiness by focusing on affordability through manufacturing and repair cost reduction, achievement of large savings in manufacturing, repair and design cycle times, reduction of scrap and rework costs through integrated design and manufacturing approaches, and streamlined production management. In particular, emphasis is placed on speeding the transition of leading-edge technologies, such as advanced composite materials, metals, and complex electronic systems, out of the laboratory and into fielded weapon systems, utilizing the latest in manufacturing techniques and processes, enterprise management systems, and business practices.
- **Civil Engineering.** Supports all aspects of technology necessary for force deployment, protection, and sustainment, including logistics planning, amphibious assault and logistics-over-the-shore, base and in-theater infrastructure (from combat trails to major logistical/operational airfields), and force protection on the battlefield and at installations and bases (from foxholes to fortifications). Of particular military consequence are support for global mobility, counter-mobility, survivability, air expeditionary forces, amphibious assault, logistics-over-the-shore, and Operational Maneuver From the Sea.
- **Environmental Quality.** Provides, in partnership with other foundational disciplines, advanced technologies that enable DoD to comply with environmental regulations, prevent pollution from defense facilities and operations, restore soil and groundwater contaminated by past practices, protect air and water quality, conserve wetlands and ranges essential for critical readiness training, reduce costs of cleanup and disposal, and protect wildlife from noise. These technologies permit our warfighters to train and operate in any theater, at any time, with minimal environmental impact, while complying with all local regulations.

MATERIALS/PROCESSES

MATERIALS AND PROCESSES FOR REENTRY VEHICLE TECHNOLOGY (MP.04.01)

Background. The Materials and Processes for the Reentry Vehicle Technology project provided key materials and process (M&P) technology for current and future reentry systems, identified alternative sources of heat shields and antenna window materials, and provided critical M&P technology to the Air Force Intercontinental Ballistic Missile (ICBM) System Program Office (SPO) and the Navy Strategic Systems Program (SSP) for flight and ground test evaluation and optional materials for critical reentry applications.

Success. Inorganic resin matrix composite antenna windows were developed, characterized, and flight tested. They met current transmission and ablation requirements and were developed and transitioned to the Air Force ICBM SPO and are available for Navy SSP evaluation. In addition, the Army is evaluating these materials for Patriot radomes. These new materials can transmit and receive, both extending the capability of the current vehicles and allowing for growth and expanded capabilities for future systems. Direct replacement heat shield materials were developed, characterized, flight tested, and transitioned to the ICBM SPO. In addition, alternative materials were developed, characterized, and ground tested and are available for evaluation and flight testing by the ICBM SPO and SSP. This DTO investigated and resolved the potential for aging of strategic system heat shield and antenna window materials, which had been a fleet sustainment issue. Fleet sustainment is critical due to the inability to replace heat shields and antenna windows (they are no longer available) and the loss of current assets due to Follow-On Test & Evaluation flights. M&P technologies were developed to provide form-fit-function replacements for current systems (heat shield and antenna windows) and to extend capabilities for future reentry systems. The ICBM SPO and Navy SSP have supported ground and flight testing of these new materials to demonstrate systems capabilities.



Completed. 1999

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Army
Navy
Air Force

INTERFEROMETRIC FIBER-OPTIC GYROSCOPE FLEXIBLE MANUFACTURING (MP.10.06)

Background. Interferometric Fiber Optic Gyros (IFOGs) are smaller, lighter, and more reliable than ring laser or mechanical gyros. The drawback to using IFOGs has traditionally been cost, driven by the fact that gyro assembly is very labor intensive with low yields. Gyros are the highest-cost items in an Inertial Measurement Unit (IMU), which in turn is the highest-cost component in a guided tactical missile or munition. This DTO succeeded in making IFOGs affordable for system use.

The ManTech effort supported the Advanced Medium-Range Air-to-Air Missile (AMRAAM) Joint System Program Office and Compass/Attitude Heading and Reference System. The objective of this effort was to reduce IFOG per-axis cost from $6,000 to $1,000. Variability reduction and semiautomation were used to improve yields and production rates. Variability reduction tools included Quality Function Deployment, Design of Experiments, and Statistical Process Control. Results were verified during two production builds (60 gyros and 5 IMUs). IFOG costs were reduced to $677/axis, and are now affordable for insertion if implemented by AMRAAM. At production rates of around 7,000 IMUs/year, this would result in a savings of $27.5 million/year. The DARPA interest was navigation-grade IFOGs, typified by a more stringent goal of supporting 1 nautical mile per hour inertial navigation performance. Lower cost and higher yields were also key goals: less than $1,500/axis, leading to one fifth the price of navigation grade inertial systems.

Success. The project has greatly reduced fiber-optic gyro cost and increased manufacturing yield, enabling more affordable and reliable navigation systems for tactical-grade and navigation-grade applications. The technology has successfully been inserted into weapon systems and the component suppliers have passed the cost reductions on to their military and commercial customers beyond AMRAAM (high-accuracy IFOG systems, fiber acoustic sensors, cable TV, etc.).

Completed. 1998

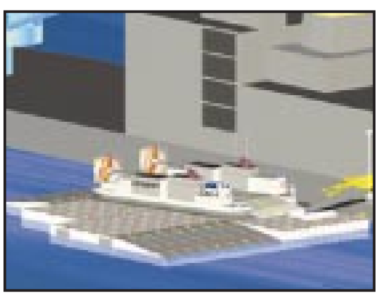
SPONSORS

Air Force
DARPA

HIGHER SEA STATE LOGISTICS SUPPORT FOR EXPEDITIONARY FORCES ATD (MP.12.11)

Background. The Higher Sea State Logistics Support for Expeditionary Forces ATD addressed the problem of transporting large quantities of bulk cargo and fuels from amphibious/sealift ships to the shore in support of landing forces. Its objective was to demonstrate an Amphibious Cargo Beaching Lighter (ACBL) for ship-to-shore cargo movement in higher sea states. Without adequate port facilities, power projection requires operational capability of Joint Logistics Over the Shore (JLOTS) operations in wind and wave conditions through sea state 3 (SS3).

Success. The ACBL will support the transfer of supplies for JLOTS for all the military services. Lighters are large, open barges used in loading and unloading larger ships (e.g., container vessels) wherever shallow waters prevent them from coming to the shore. Lighter operations are highly dependent on weather, surf, and sea state. The ATD concept uses an innovative module design with advanced connector technologies to make the module connections and assembly operable in SS3 conditions. The ACBL modules, at 40 feet long, 24 feet wide and 8 feet high, have several advantages. They are easy to transport by sea and over land. For overland transport, the module is separated into three 8-foot-wide intermodal assemblies. Aboard ship, the 24-foot-wide module either spans adjacent ISO container cells in the ship's hold (similar to the Navy Seashed) or is deck-loaded. A major full-scale realistic demonstration by the Navy amphibious elements in the open ocean waters off the coast of Virginia in 1998 confirmed the ability to assemble the modules into various platform configurations. The platforms are quick to assemble, fewer are needed in theater, and the various sizes and configurations meet changing needs at a forward logistics site. With the feasibility of an SS3-capable causeway system established, the Army and Navy have decided to pursue acquisition of the technology through its design of a Joint Modular Lighter System.



Completed. 1999

SPONSORS

Navy

LIFE-EXTENSION CAPABILITIES FOR THE NAVY'S AGING WATERFRONT INFRASTRUCTURE ATD (MP.18.11)

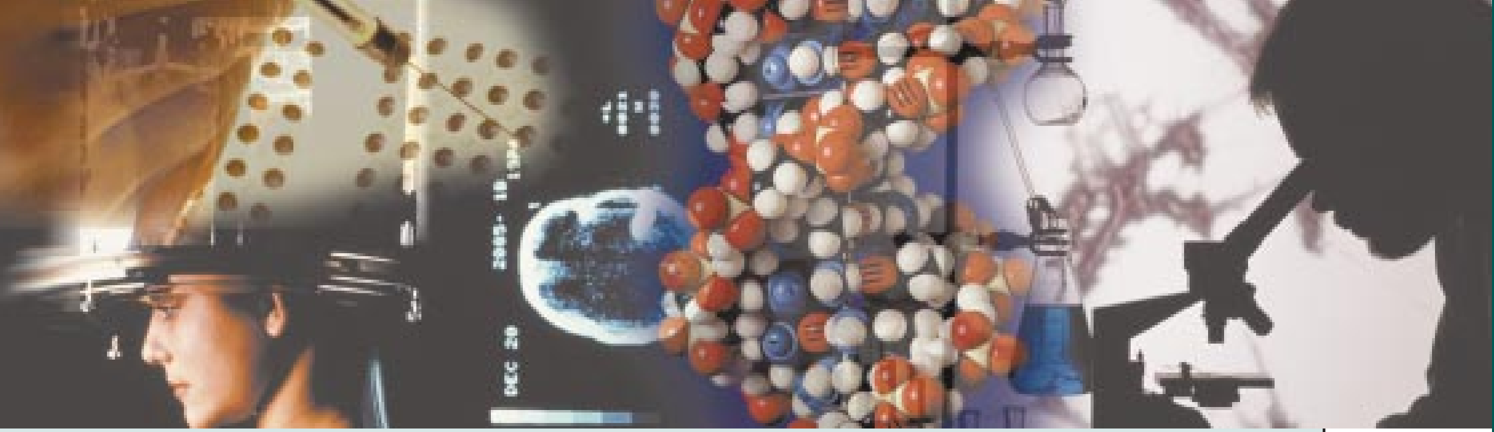
Background. The Waterfront and Repair ATD was designed to increase the structural strength and extend the service of the Navy's older deteriorating waterfront structures. The ATD incorporates composites for increased structural strength in both the vertical and the lateral directions, and a corrosion arrestment system that stabilizes the deterioration of reinforced concrete exposed to harsh marine conditions.

Success. The first of three demonstration projects to apply external composite reinforcing to increase the strength of Navy piers was completed in December 1996. Naval Station Norfolk selected Pier 11 for the demonstration of strengthening methods for two crane operating lanes to allow unrestricted operation of 90-ton capacity cranes. The second of the three projects, completed in April 1998, demonstrated advanced technologies to repair and strengthen the 47-year-old Pier 12 at Naval Station San Diego. Prefabricated, fiber-reinforced plastic shells were used for pile reinforcement. Carbon rods were inset into the top deck for reinforcement and pultruded uniaxial carbon strips were used for deck reinforcement in positive moment areas on the underside of the deck. The third demonstration at Wharf B25 at Naval Station Pearl Harbor was completed in October 1998. This project integrated an impressed current cathodic protection system to stabilize corrosion to extend the service life by over 20 years. Composites were used for deck strengthening to support operation of 50-ton cranes. Each of these repair and strengthening demonstrations, which cost under $1 million, postponed for at least ten years the need to demolish and replace the existing pier with a new structure. New structures generally cost about $50 million. With 75% of the Navy's piers more than 40 years old, and with increasing deterioration due to age, many existing piers cannot safely perform their required missions, such as accepting large mobile crane loads for conducting pierside maintenance and overhaul.

Completed. 1999

SPONSORS

Navy



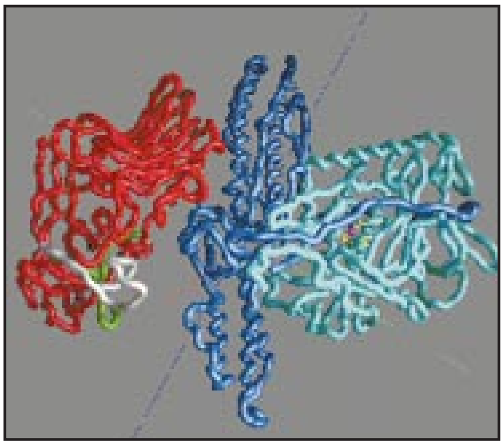
The Biomedical technology area is divided into four technology subareas: infectious diseases of military importance, combat casualty care, military operational medicine, and medical radiological defense. The program is focused to yield essential technology in support of the DoD mission to provide health support and services to U.S. armed forces. Most national and international medical S&T investment is focused on public health problems of the general population. Military medical S&T is concerned with developing technologies in order to preserve combatants' health and optimal mission capabilities despite extraordinary battle and nonbattle threats to their well-being. Preservation of individual health and well-being sustains warfighting capabilities.

The Biomedical Reliance Panel is included within the overarching structure of the Armed Services Biomedical Research Evaluation and Management (ASBREM) Committee, which provides joint coordination and cooperation within and among the four primary subareas and two additional technology subareas, medical chemical defense and medical biological defense.

The ASBREM Committee has overlapping member responsibilities with the Chemical/Biological Defense Panel. ASBREM reviews the four primary technology subareas, plus the medical chemical defense and medical biological defense subarea research programs, on an annual basis to ensure synergy across all biomedical programs.

MEDICAL COUNTERMEASURES FOR *BOTULINUM TOXIN* (MD.04)

Background. There are seven distinct stereotypes of *botulinum* neurotoxin. A pentavalent *botulinum* toxoid vaccine, which includes five toxin serotypes (A, B, C, D, and E), is not a licensed vaccine, thus limiting its broad use. The toxoid vaccine is also in short supply. Additionally, there are no drugs available for treatment of botulism intoxication. This effort, which began in 1994, will lead to the development of a recombinant multivalent vaccine that is effective against serotypes A, B, C, E, and F.



Success. In FY99, the recombinant multivalent vaccine candidate was transitioned to advanced development (program definition and risk reduction phase). The candidate vaccine will provide a minimum of 80% protection against an aerosol challenge of serotypes A, B, C, E, and F and will produce minimum reactogenicity in immunized personnel. This countermeasure will reduce the biological warfare threat of *botulinum* neurotoxins A, B, C, E, and F and will enhance the operational flexibility of U.S. forces.

Completed. 1998

SPONSORS

DoD Chemical and Biological Defense Program

MEDICAL COUNTERMEASURES FOR *YERSINA PESTIS* (MD.14)

Background. *Y. pestis*, the causative agent for plague, is a validated biological warfare threat of high priority. Bubonic and pneumonic plague caused by *Y. pestis* are serious threats to the warfighter. Plague is a disease of rapid onset and high death rates. The effects of aerosol exposure could be further exacerbated by secondary human-to-human spread from infected personnel. The licensed vaccine for this disease is not currently manufactured and is therefore not available for force protection. In addition, the licensed vaccine was too reactogenic, induced short-lived immunity, required multiple immunizations, and was of unproven efficacy against an aerosol exposure. Antibiotics may be effective for prophylaxis (pre-exposure treatment) and for post-exposure therapy.

Success. In FY99, a next-generation (recombinant) vaccine candidate obtained a Milestone 0 (concept exploration phase). The candidate vaccine is expected to protect 80% of immunized personnel against an aerosol challenge of *Y. pestis* with minimum reactogenicity. This new vaccine candidate should protect against parenteral and aerosol exposures to *Y. pestis*, have long-lasting immunity, and protect against the three different forms of the disease. The combination of prophylactic (vaccine) and therapeutic (antibiotic) treatments will afford the warfighter with a greater degree of protection against infection with plague, deter its use as a biological warfare agent, and increase the strategic mobility of U. S. forces.

Completed. 1998

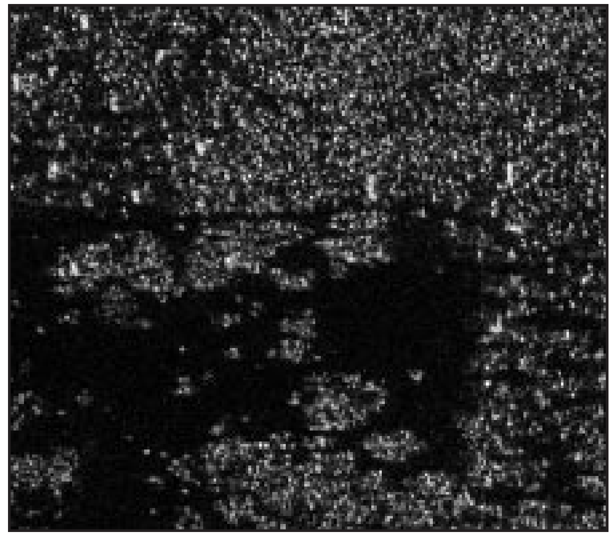
SPONSORS

DoD Chemical and Biological Defense Program

The Sensors, Electronics, and Electronic Warfare (SEEW) program area addresses technology for sensors, electronics, and electronic warfare in three subareas. The sensor technology developed here has broad applications to warfighting needs including strategic and tactical surveillance as well as identification and targeting of land, sea, air, and space threats under all conditions. In addition, SEEW encompasses the research and development, design, fabrication, and testing of electronic materials; digital, analog, microwave, optoelectronic, and vacuum devices and circuits; and electronic modules, assemblies, and subsystems. Finally, SEEW is responsible for developing technology that provides U.S. military forces with the capability to survive in their execution of all operations/missions by maximizing their unchallenged operational use of the electromagnetic (EM) spectrum—while denying the same from the enemy by using EM means to detect and attack enemy sensor, weapon, and command infrastructure systems.

SENSORS, ELECTRONICS, AND ELECTRONIC WARFARE

FOLIAGE PENETRATION DETECTION ALGORITHM DEMONSTRATION (SE.02)



Background. The objective of this joint Army and Air Force effort was to demonstrate radar sensor, signal processor, and signal detection and discrimination algorithms tailored to detect and discriminate targets concealed in foliage. This real-time demonstration used COTS hardware and automatic concealed target detection algorithms to verify the automatic target detection performance achieved against broadside targets hidden in foliage.

Success. The technical challenges that were successfully demonstrated included synthetic aperature radar (SAR) sensors that provided foliage penetration and radar signal processing algorithms that provided a 90% detection probability with less than 0.1 false-alarm-per-square-kilometer against time-critical targets. The real-time target algorithms were transitioned/delivered to the Counter Camouflage Concealment and Deception ATD.

The Radiation Control (RADCON) Program developed and demonstrated real-time Image Formation Processing (IFP) and Automatic Target Detection and Cueing (ATD/C) algorithms on COTS processing hardware. The IFP and ATD/C algorithm technology transitioned to the current joint DARPA/Army CECOM/AFRL Foliage Penetration Radar (FOPEN) ATD, which is to design, develop, build, and test a FOPEN radar on a manned aircraft.

Completed. 1998

SPONSORS

Army
Air Force

ADVANCED PILOTAGE (SE.07)

Background. Advanced Helicopter Pilotage (AHP) was a key Army Aviation Science and Technology Objective (STO) demonstration of dual-spectrum helicopter night pilotage sensors and Helmet Mounted Displays (HMD). The AHP program developed the first practical system designed specifically for helicopter pilotage application. AHP consists of a Texas Instruments, Inc., (now Raytheon TI Systems) second-generation forward-looking infrared (FLIR), a Lockheed Martin Fairchild Systems high-definition image intensified (I^2) camera, and a Kaiser Electronics, Inc., HMD and head tracker. As a system, the sensors are turret-mounted and slaved to the direction of the pilot's head by the head tracker. In addition to the individual sensors, the pilot can also select real-time image fusion of the FLIR and I^2 imagery for viewing on the 30° x 50° HMD.

In addition to providing system-level performance benchmarks and component-level risk reduction for the RAH-66 Comanche program streamlining, AHP demonstrated robust, reduced risk, 30° x 50° wide field of view (FOV) sensors and HMD. The system design combined key technologies including Standard Advanced Dewar Assembly I detector for the FLIR, third generation I^2 tube mated with high-definition charged coupled devices (CCD) for the I^2 camera, wide FOV HMD, advanced image processing for increased dynamic range, and image fusion. Because the sensors and displays are optimized for the pilotage task, AHP demonstrated real improvements in safety and survivability through improved low-level and nap-of-the-earth flight. Risk reduction includes the demonstration of advanced thermal sensor components, I^2/CCD sensors development, and head-mounted flight testing.

Success. The image intensification and second-generation thermal imaging demonstrated a 50% improvement in resolution and a 25% increase in FOV, along with a dual-spectrum system that uses an HMD. Low-light-level CCD and advanced thermal imaging technology approaches were fused and tested for operations in various thermal contrast and light level conditions. The Army successfully demonstrated an integrated pilotage/navigation sensor and display suite with image fusion and transitioned the system for flight testing to PM Rotorcraft Pilot's Associate (RPA).

Completed. 1998

SPONSORS

Army
Navy

MILLIMETER-WAVE POWER MODULES (SE.26)

Background. The goal of the MilliMeter-wave Power Module (MMPM) DTO was to develop a compact, lightweight, highly efficient transmitter module primarily for communications and electronic warfare (EW) applications. Specific goals for the DTO included instantaneous bandwidth between 18 and 40 GHz, wideband DC-to-RF efficiency greater than 30%, continuous wave (CW) power in the 40 to 50 watt range, and a volume of 30–35 in^3. The MMPM is an extension of the Microwave Power Module concept that integrates a solid state driver and vacuum power booster with high- and low-voltage power conditioning. The overall payoff was development of a wideband millimeter wave transmitter prototype that could be used in volume- and weight-constrained applications such as airborne or vehicle-based EW and communications systems.

Success. This DTO advanced the technology of compact, wideband transmitters operating in the 18–40 GHz band and resulted in a 30x improvement in power-bandwidth product over existing technologies. Achievement of the results required the development of the following: a wideband solid-state driver with sufficient gain, temperature stability, and power output to support the vacuum power booster; power extraction circuitry (windows, couplers) for the vacuum power booster; and wideband isolators and circulators. Using this technology base, a narrowband MMPM has been developed that is applicable to a MILSTAR uplink. This DTO was sponsored by the Navy with tri-Service participation.

Completed. 1998

SPONSORS

Navy
Air Force

MICROWAVE SiC HIGH-POWER AMPLIFIERS (SE.27)

Background. The Microwave silicon carbide (SiC) High-Power Amplifiers objective was to develop compact, lightweight, highly effective L- through X-band microwave solid-state transmitter building blocks for potential use in high-performance radar, communications, and EW systems. This DTO directly supported the Air Force's AN/TPS-75 ground-based radar transmitter upgrade, impacts Army Patriot, ground-based radar, and theater high-altitude air defense systems, and affects ground-based, shipborne, and airborne surveillance, fire control radars, and EW jammer equipment.

Success. This DTO significantly improved the technology of SiC transistors for application in advanced microwave high-power amplifiers. Pulsed 3 GHz SiC static induction transistors were improved from the 75-watt range to over 300 watts. SiC metal-semiconductor field-effect transistors (MESFETs) for CW operation at 10 GHz were improved from the 1-watt level to around 10 watts. The process capability for these devices was improved, resulting in a demonstrated epitaxy layer uniformity of 5%, as well as the first commercial release of an SiC radio frequency (RF) power transistor in July 1999. The impact of this technology is a 2-5x improvement in the power per device and an increase in operating temperature range from 125°C to 250°C. The resulting 2-5x decrease in the size and weight of RF power amplifiers provides the warfighter with improved mobility and reliability in a multitude of radar, communications, and EW systems. This DTO was sponsored by the Air Force, Navy, and DARPA, with tri-Service participation. Potential system insertions include the Air Force TPS-75 S-band radar upgrade, towed decoys such as ALE-50, and multifunction active arrays for the Navy's SC-21 platforms.

Completed. 1999

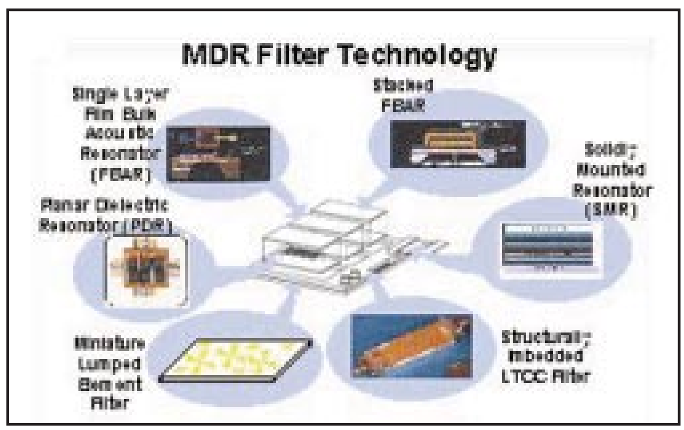
SPONSORS

Navy
Air Force
DARPA

LOW-POWER RADIO FREQUENCY ELECTRONICS (SE.28)

Background. The objective of the Low-Power Radio Frequency Electronics DTO was to develop new, lower-power RF devices and components needed to improve sensitivity, selectivity, and dynamic range while minimizing power consumption in planned and ongoing communications and sensor-based systems. Present microwave and RF electronics for antenna arrays used on airborne and space-based platforms are inadequate in terms of size, weight, and power consumption.

Success. This DTO advanced the technology of miniature digital receiver and waveform generator modules, resulting in an approximate 10x reduction in size and weight. Technologies developed included low-temperature co-fired ceramic multichip assemblies employing embedded passive filters that demonstrated less than 1 dB loss and over 40 dB rejection. Using this technology, a multifunction radar/electronic surveillance measures (ESM) digital front-end capability was demonstrated. A modular "building-block" approach was employed to allow design re-use. This DTO provides the warfighter with an enabling technology for advanced system concepts, especially for UAV and space-based reconnaissance platforms where size and weight reductions are critical. This technology program, funded and managed by the Air Force, has been transferred to the Air Force Modular RF System program; and provides technology to DTO SE.63 Digital Beamforming Antenna Technology, as well as DTO SE.71 Advanced Multifunction RF System Components.



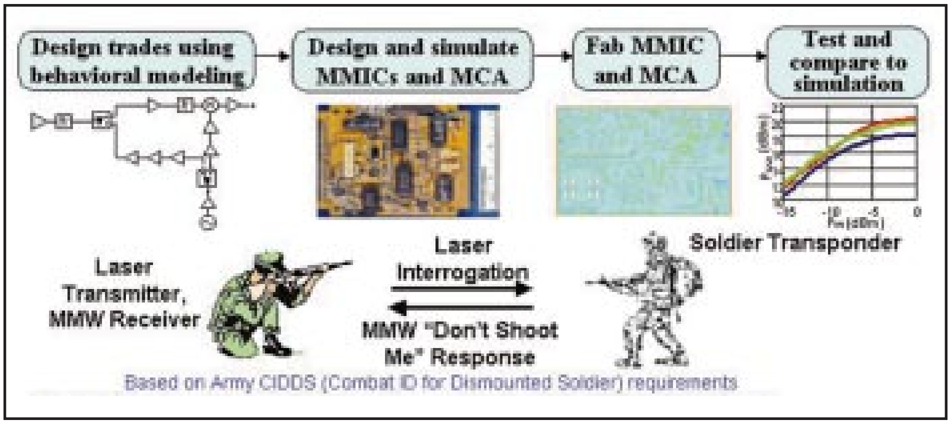
Completed. 1999

SPONSORS

Air Force

DESIGN TECHNOLOGY FOR RADIO FREQUENCY FRONT ENDS (SE.29)

Background. The Design Technology for Radio Frequency Front Ends DTO developed tools and processes for the rapid and efficient design of monolithic microwave integrated circuits, multichip assemblies, and mixed-signal electronic subsystems for use in high-performance, military essential electronic warfare, radar, and communication systems. The overall payoff was to drive down front-end costs, increase front-end capabilities, enhance portability, upgrade reliability, and reduce life-cycle costs.



Success. This DTO advanced the technology of RF multichip assembly design by reducing the total non-recurring engineering (NRE) and design cycle time and improving the accuracy of RF design simulation. Specific improvements demonstrated included 3x faster design capture, 100x faster circuit simulation, and 1,000x faster electromagnetic simulation. Simulation accuracy was improved by 4x from 20% down to the 5% range. As a result of these improvements, modules NRE reduced from 20 person years down to 8 and design cycle time reduced from 3 years down to 1–2. The payoff of these improvements is to put advanced system technologies in the hands of the warfighters years sooner by reducing the up-front design cycle. Many of the design software improvements demonstrated by this DARPA-sponsored, Air Force–managed program have been commercialized in the latest version of the Hewlett Packard Microwave Design System. The improved design capability was successfully demonstrated and validated through the design of a variant of the Combat ID Dismounter Soldier (CIDDS) Integrated Combat Identification interrogator/transponder.

Completed. 1999

SPONSORS

Air Force
DARPA

The Human Systems technology area provides technologies, techniques, and tools to ensure that the military's most critical resource – its people – are properly selected, trained, and equipped to perform as effectively and as safely as possible. Cost reduction through more efficient use of personnel and equipment is also a key goal. Four subareas comprise the Human Systems technology area.

- **Information Display and Performance Enhancement** supports future joint- and Service-unique warfighting needs in data visualization and situational understanding, aural and visual interfaces, immersive interfaces, intelligent and decision support aids, decision-centered staff process control, supervisory control and teleoperation, and physical aiding.
- **Design Integration and Supportability (DI&S)** supports the fielding of affordable, effective equipment for current and future military operations. DI&S advances the state of the art in human systems design tools, performance requirements estimation, performance metrics, human system integration, logistics readiness, and sustainment logistics.
- **Warrior Protection and Sustainment** supports warfighting and peacekeeping mission capabilities through full-spectrum personal protection; troop sustainment, including rations and field feeding equipment; aircraft escape/crash safety, survival, and rescue; advanced airdrop (both personnel and cargo); and dismounted, mounted, and aircrew warrior systems integration, including warfighter systems analysis.
- **Personnel Performance and Training** strengthens unit readiness and reduces costs (e.g., selection, school/job assignment, retention) through advances in force management and modeling, selection and classification, human resource development, simulation-based training, training strategies, and training efficiency.

HUMAN SYSTEMS

ADVANCED HYBRID OXYGEN SYSTEM - MEDICAL (HS.02)

Background. The Advanced Hybrid Oxygen System-Medical (AHOS-M) provides portable, self-producing oxygen system technology targeted for aeromedical evacuation and field casualty care operations in Aeromedical Staging Facilities, Air Transportable Hospitals/Clinics, and theater-level Medical Treatment Facilities. The system, designed to generate, liquefy, and store medical-grade (>99%) oxygen in a single integrated package, will meet warfighter needs documented in Headquarters (HQ), USAF Mission Needs Statement (MNS) 003-96: Aeromedical Evacuation Advanced Capability. Developed by the AFRL's Biodynamics and Protection Division, the technology is being transitioned to the Human Systems Program Office at Brooks AFB, Texas, for Engineering, Manufacturing, and Development. Customers are HQ AMC/SG and HQ ACC/SG.

Success. Existing Molecular Sieve Oxygen Generation Systems (MSOGS) technology being installed on fighter and bomber aircraft 1) is too large and heavy for aeromedical and transport aircraft applications requiring high oxygen flow rates, 2) cannot generate high-purity oxygen, and 3) cannot store large quantities of oxygen. AHOS-M eliminates these shortcomings by successfully coupling, for the first time ever, a high-performance MSOGS (HP-MSOGS) unit with miniaturized, high-speed turbomachines for oxygen liquefaction. The HP-MSOGS uses multiple molecular sieve beds to produce 30 gaseous liters/minute of >99% oxygen. The cryogenic refrigeration subsystem converts gaseous oxygen to liquid oxygen (LOX) at the rate of 2 liters/hour and has integral LOX storage. The system can provide gaseous oxygen for delivery to patients at flow rates up to 72 liters/minute. The FY99 completion of the AHOS-M DTO provides lightweight, high-reliability technology to replace the time-, cost-, and maintenance-intensive LOX infrastructure currently required to support aeromedical missions. AHOS-M offers significant warfighter payoffs by reducing deployment support requirements and increasing rapid deployment capability.

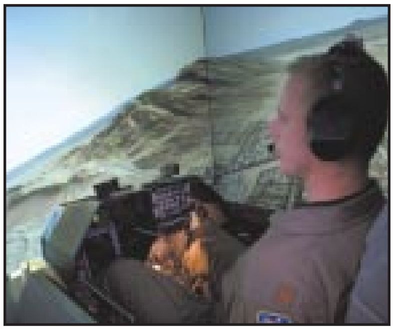
Completed. 1999

SPONSORS

Air Force

AIRCREW DISTRIBUTED MISSION TRAINING TECHNOLOGY (HS.03)

Background. Technical barriers include visual-system resolution preventing aircrew trainees from determining the aspect angle of friendly/enemy-simulated aircraft at real-world distances. Terrain databases are not large enough to accurately represent a theater-wide environment. Simulated sensor systems are not fully multispectral. Simulation instructor-operator stations frequently either constrain the way instructors want to train, or make the interface with the simulator too complex. Simulator cockpit avionics systems are too artificial due to their use of lookup tables that are often not dynamic enough to represent the actual physics environment of flight. Unconstrained training will be available for aircrews to train against any combination of virtual, live, and constructive assets on demand. Mission rehearsal is now quite feasible with accurate multispectral threats and databases. Simulator visual systems now allow air warriors to train in air-to-air and air-to-ground environments with 20/40 visual resolution capability, making tactical employment more lethal.



Success. This DTO developed, demonstrated, and evaluated affordable training techniques to improve aircrew training capability in local and geographically distributed modes of multi-aircraft formations. It also developed and adapted high-fidelity, low-cost simulation technologies that allow aircrews to train as they intend to fight, and linked virtual, live, and constructive simulation assets together to allow warfighters to learn and practice their individual and team combat skills in a synthetic battlefield. Results have been transitioned to warfighter, industry, and government acquisition agencies/customers.

The Distributed Mission Training (DMT) DTO (HS.03) produced training technologies and methods that have been embraced by Air Force tactical warfighters. The ACC developed and is using four-ship simulator Mission Training Centers (MTCs) for the F-15C. Additional MTCs for the F-16C are being built. Aircrews that use DMT technologies consistently state that their DMT training experiences have better prepared them to perform tactical tasks and missions for which there is little or no opportunity to prepare during traditional training events. "It's easily the best prep for 4-ship Flight Lead upgrade training," says one F-16 pilot.

Completed. 1998

SPONSORS

Army
Air Force

DEVELOPMENT OF ADVANCED EMBEDDED TRAINING CONCEPTS FOR SHIPBOARD SYSTEMS (HS.09)

Background. This project was the first large-scale demonstration of how intelligent tutoring principles could be employed in a complex system. The capability that exists as a result is a mechanism to embed intelligent training into a complex operational system. Modern naval strategy calls for more varied missions with fewer people. The system demonstrated would enable this by providing deployed personnel the opportunity to train realistically for the missions they are facing.

Success. The result will be improved combat readiness (improvements in the 25–40% range based on past work are anticipated). In addition, reducing the number of instructors (both shore-based and shipboard) required to conduct training lowers the workload on the crew (enabling reduced manning) and can save almost $1 billion over the life of a platform. The shipboard Mobile Aid for Training and Evaluation tool has been transitioned to Aegis, BFTT, and ATGs; the prototype system was transitioned to Aegis Training and Readiness Center; system concepts were transitioned to DD21, LPD17, CVX, and Army FORSCOM Scenario-Based Training program; and cognitive models were transitioned to SC21 Reduced Manning for Affordability project. This DTO successfully demonstrated that experienced combat teams could use the system and that it has training value.

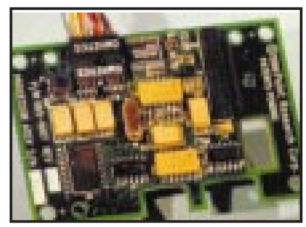
Completed. 1998

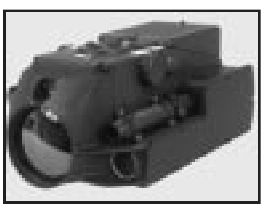
SPONSORS

Navy

FORCE XXI LAND WARRIOR (HS.10)

Background. The Force XXI Land Warrior (LW) DTO developed and demonstrated advanced technology insertions to the LW system, and measured the individual and operational effectiveness afforded by these advanced technologies. The DTO was completed by the Soldier and Biological Chemical Command (Natick Soldier Center) with U.S. Marine Corps involvement.





Success. Low-power helmet electronics and an improved helmet suspension system were transitioned to LW Engineering and Manufacturing Development (EMD) in FY97. Integrated technology demonstrations were conducted in FY99 for the system voice control, integrated navigation, combat identification (ID) functionality (to include interoperability with stand-alone CIDDS, Multiple Integrated Laser Engagement System (MILES), and MILES 2000 training devices), integrated sight, and soldier radio enhancements. These demos also proved the viability of the extended-life batteries, utilizing lithium manganese dioxide pouch cell chemistry, within a dismounted platform. The Future Warrior Architecture (FWA) team developed an objective approach to evaluate and measure a system's physical fightability and recommended a path forward to a future lightweight, low-power, affordable warrior system. These technologies provide enhanced individual and small-unit performance, lethality, and mobility and survivability. Specific benefits include accurate individual geological information when the Global Positioning System (GPS) is not available, hands-free control of LW functions, positive ID of friendly LW and non-LW combatants, lower power requirements for LW helmet system, and improved helmet adjustment capability. An additional benefit is that the technology is leading toward significant weight and bulk reduction for thermal sensors, and concepts for an FWA that helps to focus future S&T efforts on a future lightweight, low-power, affordable warrior system. Based on this effort, the LW operational requirements document has been revised to include integrated navigation and combat ID functionality as threshold requirements. Other capabilities demonstrated are cited as objective requirements of the LW system.

Completed. 1999

SPONSORS

Army

HUMAN PERFORMANCE METRICS FOR THEATER MISSILE DEFENSE (HS.14)

Background. Human performance metrics technology was advanced in several areas during the 3-year life of this DTO. Specifically, the Subjective Workload Assessment Technique (SWAT), the Subjective Workload Dominance Technique, and a variety of physiological measures of workload were refined for field test support applications. Operator metrics technology was successfully demonstrated during Roving Sands, Gold Pan, and PACER CRAG. The Air Force Operational Test and Evaluation Center (AFOTEC), for example, continues to use these metrics in its flight test activities.

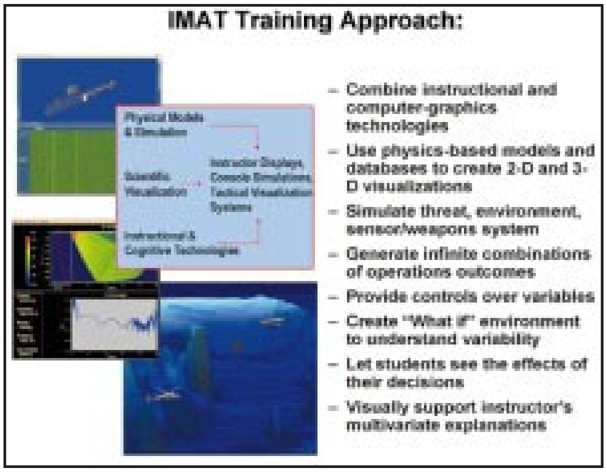
Success. The SWAT redline concept was further validated by a demonstration that a SWAT score in the range of 40 indicated impending overload and performance breakdown in a complex theater missile defense (TMD) simulation. Finally, neural-network-based classification of overload, using a combination of behavioral and physiological measures, was demonstrated with an accuracy of 98%. The DTO contributed to the identification of the most effective components of the TMD Eagle Smart Sensor and Automatic Target Recognition field tests. DTO flight test activities also confirmed that the PACER CRAG upgrade to the KC-135 supported acceptable workload, despite the elimination of the navigator position. This manpower reduction is projected to save $20 million annually. Real-time workload classification, further developed under this DTO, is expected to be a key component of real-time decision support and adaptive systems technology being developed by each of the services. Further development of this technology will be the focus of continued Air Force metrics research. The TMD simulation developed under this DTO generated an initial database for the comparison of competing models of operator workload being used in Canada, Australia, and the United States. This database was provided to collaborators at the U.S. Army Research Laboratory and the Defense and Civil Institute of Environmental Medicine in Canada. The SWAT redline concept represents a product transition, since the validation extended its applicability to a range of new tasks and work environments.

Completed. 1999

SPONSORS

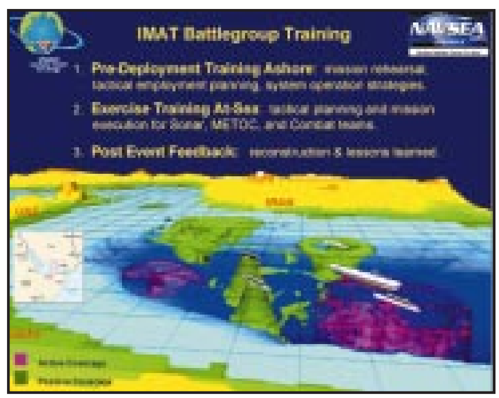
Air Force

INTERACTIVE MULTISENSOR ANALYSIS TRAINING TECHNOLOGY (HS.16)



Background. The objective of Interactive Multisensor Analysis Training (IMAT) was to develop and demonstrate new methods for training tactical and analytic tasks employing complex sensor systems in a range of undersea warfare (USW) applications.

Success. The project developed new training technologies for acoustic and nonacoustic sensor systems employed by subsurface, surface, and aviation USW communities, including computer models and scientific visualizations of physics phenomena integrated into curricula. IMAT has transitioned to all sonar apprentice schools, and over 20 advanced courses across all USW communities, at enlisted and officer levels. IMAT is also used for at-sea training for submarine, surface, air, and combined exercises. In school, IMAT students significantly outperformed students in conventional instruction, and often scored higher than qualified fleet personnel with 3 to 10 years' experience; IMAT increased instructors' ability to teach difficult topics, respond to student questions, and reinforce critical principles; IMAT students scored higher on measures of attention, relevance, confidence, and satisfaction than students in standard Navy classrooms or in computer-based training; and development costs are equal to or less than conventional courses and less expensive than other new training technologies; at-sea, IMAT-trained submarine crews significantly improved their tactical sonar skills and performance on independent Tactical Readiness Evaluations (according to N-87, this translates to a 10-dB performance advantage), and IMAT improved interplatform coordination in combined operations. Payoffs include significant improvement in sensor operator skills through complete revision of submarine and air sonar training, and a reduced-cost submarine sonar employment trainer programmed for acquisition in FY00. The IMAT project was completed by the Space and Naval Warfare Systems Center, San Diego, and the Naval Surface Warfare Center, Carderock Division.

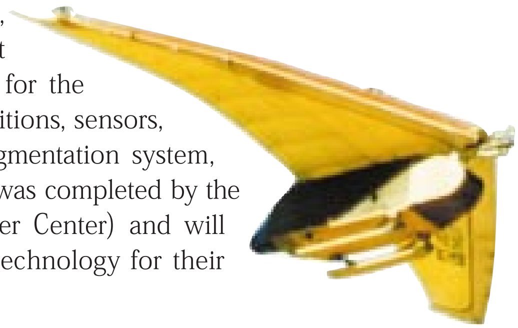


Completed. 1999

SPONSORS

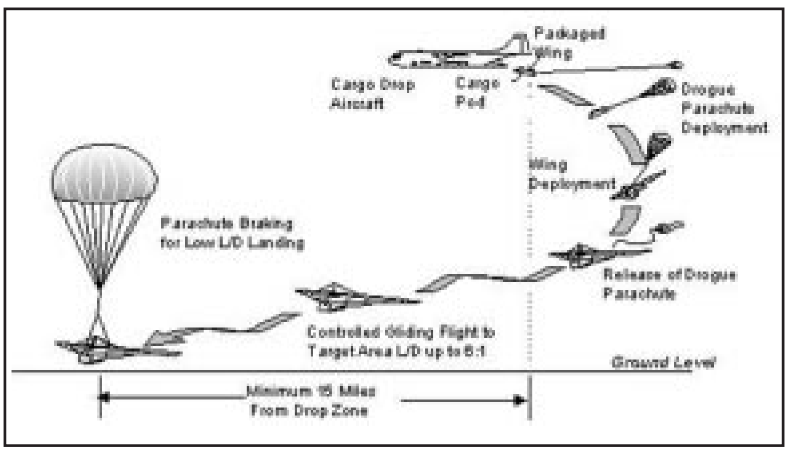
Navy

PRECISION-OFFSET, HIGH-GLIDE AERIAL DELIVERY OF MUNITIONS AND EQUIPMENT (HS.18)



Background. The objectives of the Precision-Offset, High-Glide Aerial Delivery of Munitions and Equipment DTO were to 1) demonstrate revolutionary technologies for the reliable precision-guided delivery of combat-essential munitions, sensors, and equipment, and 2) demonstrate an optional glide augmentation system, providing an offset range of 75 km to 300 km. The DTO was completed by the Soldier and Biological Chemical Command (Natick Soldier Center) and will transition to PM Soldier Support in FY02 as a candidate technology for their precision airdrop program.

Success. This DTO demonstrated reliable precision guided delivery using Semi-Rigid Deployable Wing technology from 25,000 feet altitude and 15 miles offset, as well as a 6:1 glide ratio (a 200% increase over conventional parafoils). A modular GPS-based guidance navigation and control system was developed and demonstrated. A glide augmentation system was integrated to extend the range of the vehicle over 300 km. Multiple payload/drop zone capability was demonstrated, and flights were successfully conducted in adverse weather (rain and wind). Novel aerodynamic decelerator designs with airdrop-unique materials were adapted and integrated to increase performance. This system was also demonstrated to interface with standard USAF aircraft and Army helicopters.



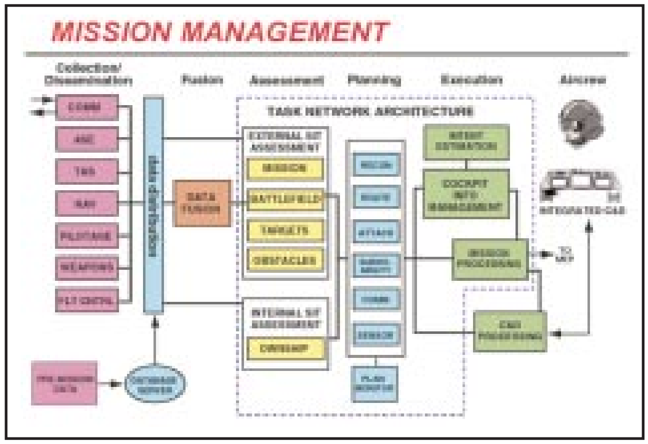
Completed. 1999

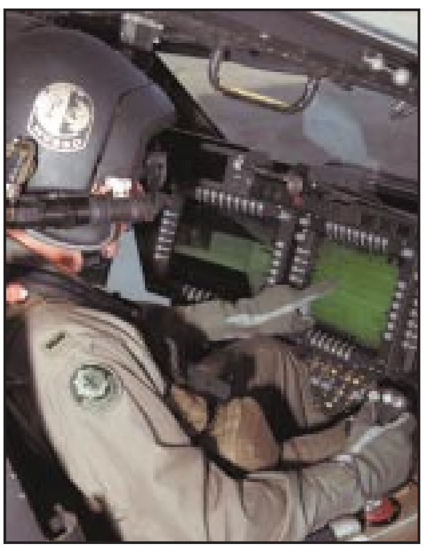
SPONSORS

Army

ROTORCRAFT PILOT'S ASSOCIATE ATD (HS.19)

Background. The objective of the Rotorcraft Pilot's Associate (RPA) was to increase battlefield situational awareness, lethality, crew system performance and survivability through a cognitive decision aiding interdependent man/machine expert cockpit system. RPA was designed to demonstrate the use of Cognitive Decision Aiding Technology to aid the rotorcraft crew. RPA technology monitors all sensors and electronic traffic, establishes a comprehensive awareness of the battlefield at a machine as well as human level, and uses this awareness to develop and present plans of action and automate routine tasks. Of particular interest to the operational pilots is the increased ability to replan on the move, conduct team-coordinated search patterns, immediately share and hand off targeting information with teammates, and automatically report own-ship and teammate status. Auto-generated visual and voice warnings, including verbal directions to safe masking areas, have been lauded as well-implemented new capabilities.





Success. Portions of the RPA's demonstrated capabilities have been transitioned to other organizations. RPA software (route and battle position planning) has been integrated into the Mounted Maneuver Battlespace Lab for ground vehicle simulation exercises. RPA software and hardware are being integrated into the Air Maneuver Battle Lab for manned/unmanned vehicle teaming and control exercises in December. RPA is also targeted for transition to scout and attack helicopters such as Comanche and Apache. RPA has demonstrated application to command and control and is targeting both air and ground future command systems. The RPA software architecture was selected by DARPA as the baseline for the Unmanned Combat Air Vehicle Program.

Completed. 1999

SPONSORS

Army

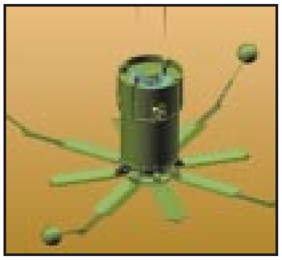
The Weapons technology area includes efforts devoted to armament technologies for all new and upgraded nonnuclear weapon systems. The Weapons area consists of two subareas, Conventional Weapons (CW) and Directed Energy Weapons (DEW). The efforts in these subareas are directed toward providing demonstrated technology that better enables the warfighter to incapacitate or destroy enemy personnel, materiel, and infrastructure and to provide defense against or countermeasures to an enemy's ability to wage war.

CW focuses on munitions, their components and launching systems, guns, tactical propulsion, bombs, rockets, guided missiles, projectiles, special warfare weapons, mortars, mines, countermine systems, torpedoes, and explosive ordnance disposal.

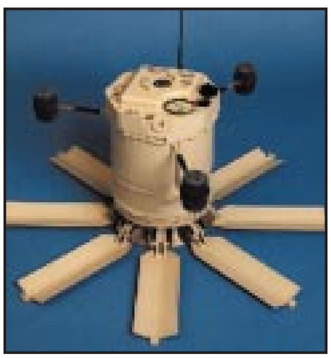
DEW technologies are those that relate to the production and projection of a beam of intense EM energy or atomic/subatomic particles that are used as a weapon. DEWs and devices generate energy that travels at or near the speed of light from a beam source directly to the target.

WEAPONS

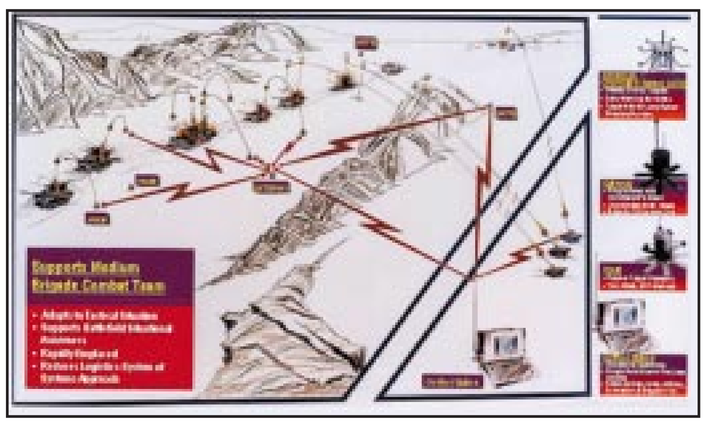
LAND MINES (WE.02)



Background. This DTO demonstrated an affordable, rapidly deployable land mine system for early entry operations with 50% greater kill probability against armor vehicles. To achieve the objective of this program, the Intelligent Minefield ATD internetted wide-area munitions and advanced acoustic sensors into an autonomous antiarmor/antivehicle system. The control station and data fusion technology were transitioned to the Rapid Force Projection Initiative (RFPI) ACTD in FY98. This ATD also transitioned to Raptor, a PM-Mines, Countermine, and Demolition program.



Success. The DTO demonstrated 1) communications, command, and control 2) sensor fusion of acoustic sensor data 3) autonomous implementation of engagement tactics 4) advanced acoustic sensor and 5) exportable combat and target information. The DTO successfully demonstrated the following: gateway functions (real-time acoustic tracking and classifying, engagement algorithms, sensor data fusion); improved tracking and kill probability; ability of the gateway to convert a user-selected strategy into an optimized, synergistic engagement solution for the smart munitions; ability to remotely control wide-area munitions (WAM's) turn-on/off and receive status; the ability to track seven vehicles simultaneously; and the ability to track a single vehicle with overall 3-degree tracking accuracy and 2- to 4-km range using the acoustic (over watch) sensors. The payoff includes a 50% improvement in maximum WAMs field performance and early alert and target information to the brigade tactical operations center (TOC) and WAMs field.



Completed. 1997

SPONSORS

Army

FUTURE MISSILE TECHNOLOGY INTEGRATION PROGRAM (WE.07)

Background. The purpose of this DTO was to demonstrate the technologies to enable a multiplatform, multitarget, multi-mission extended range fire-and-forget missile that is size compatible with the Tube-launched Optically-tracked Wire-guided missile (TOW) and Hellfire family of launchers. These technologies include high resolution/sensitivity imaging infrared (IR) sensor, advanced algorithms for automatic target recognition (ATR) and acquisition, controlled thrust propulsion, and high bandwidth data link.

Success. The performances of these technologies were demonstrated by captive flight test, tower tests, Six Degrees of Freedom and hardware-in-the-loop simulations and live missile firings. An RF data link capable of transmitting live missile sensor imagery for ATR processing and/or man-in-the-loop target acquisition was demonstrated in tower tests to perform at ranges greater than 15 km. Captive flight testing of an imaging infrared (IIR) seeker demonstrated the capability to detect and lock onto armor vehicles at ranges greater than 4 km. The program was concluded with two successful missile firings from a TOW launcher on the Bradley Infantry Fighting Vehicle. The first flight demonstrated the smart energy management capability of the gel propulsion system by flying approximately twice the range of a comparable-size missile using solid-propellant, boost-coast propulsion. The second flight test demonstrated performance of the full-up Future Missile Technology Integration (FMTI) missile including IIR seeker, RF data link, and ATR. The successful demonstration of FMTI technologies and the resulting potential for a relatively lightweight, multipurpose missile address many of the attributes of the Army Transformation vision. These technologies are currently being considered for use in the Common Missile program.

Completed. 1998

SPONSORS

Army

ANTIJAM GPS TECHNOLOGY FLIGHT TEST (WE.12)

Background. The Antijam GPS Technology Flight Test (AGTFT) program team has designed, fabricated, ground and free flight tested an antijam GPS/inertial navigation system (INS) guidance/navigation system using a modified JDAM. The key objective of the program was to demonstrate the performance and technology maturity of a high-antijam GPS system, for the lowest incremental cost, added to a smart munition—the JDAM.

Success. The AGTFT program modified a JDAM tail kit to add a low-cost GPS antijam system that can be easily added to other air-to-ground weapons. The program proved that the system operates satisfactorily against a high-level jamming environment in the target area. On four AGTFT free flights, the AGTFT flight test vehicles (FTVs) hit within a circular error probability (CEP) of 4.4 meters with the Target Location Error (TLE) not included. Factoring in a 7.2 meter TLE, the CEP is 8.4 meters. The miss distance from the target pole did not exceed 6.7 meters under a high-jamming environment. The FTVs were dropped from 44,000 feet mean sea level (MSL) and at a range of approximately 9 nautical miles (NM) from the target pole. The AGTFT design is physically and functionally mature.

The delta to JDAM unit cost is estimated to be $6,000 for small numbers (5,000 units). This unit cost delta would be reduced if antijam became part of the baseline JDAM production configuration and the quantities of antijam devices were increased.

Completed. 1998

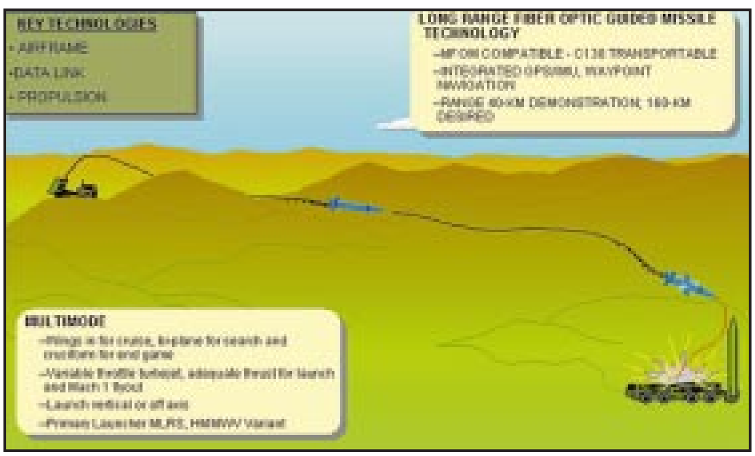
SPONSORS

Air Force

MULTIMODE AIRFRAME TECHNOLOGY DEMONSTRATION (WE.25)

Background. This DTO demonstrated, through modeling, simulation, and flight testing, a 40-km-range, day/night system that is compatible with the MLRS family of missiles and capable of striking multiple high-value, time-sensitive point targets while inflicting minimal collateral damage. This capability was achieved by means of integrated GPS and inertial navigation, variable-threat air-breathing propulsion, composite material airframe providing low IR signature and low radar cross section, variable geometry wings, IIR seeker, and other technologies.

Success. Bobbin design was accomplished in FY95, the captive flight test was performed in FY96, and the active missile sled test was accomplished in FY97. This system will provide the capability to select priority targets after launch, conduct limited man-in-the-loop bomb damage assessment (BDA), and provide target area reconnaissance in addition to target attack by means of variable cruise velocity over areas of interest. Transition to the 6.3 program occurred in FY98. Results of this effort transitioned to follow-ons in missile and rocket advanced tech-nology.

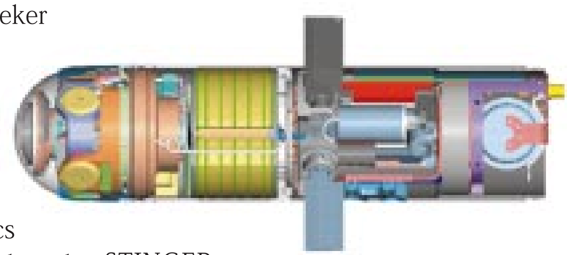


Completed. 1998

SPONSORS

Army

SMALL-DIAMETER ANTIAIR INFRARED SEEKER (WE.51)



Background. The Small-Diameter Antiair Infrared Seeker DTO developed and demonstrated a small diameter (2.75 inches) IIR seeker that can provide improved target engagement capability for man-portable and lightweight crew-served air defense missile systems.

Success. The ability to package the seeker electronics within a 2.75-inch diameter by 2-inch length to fit within the STINGER airframe was the major barrier overcome. The ability to engage helicopter targets in terrain clutter at ranges in excess of 3x current capability and the ability to engage aircraft deploying IR countermeasures were demonstrated in a number of field tests. This DTO was conducted in conjunction with the STINGER Block II Integration program administered by the Short Range Air Defense project office. This program will now become a transition to the STINGER Block II EMD program funded by STINGER Program Management Office (PMO). Completed in FY99, accomplishments include packaging of electronics, development of tracker, integration with Infrared Focal Plane Array (IRFPA) seeker, and demonstration of performance by meeting STINGER Block II requirements. This DTO also fabricated four IRFPA seeker heads, fabricated six sets of electronics hardware, developed and integrated trackers and Infrared Counter-Counter Measures (IRCCM) software algorithms, developed Hardware-in-the-Loop simulation, and guidance assembly with controller operating in-house. WE.51 completed Acquisition and Tracking Field Tests at Redstone Arsenal Russell Tower, IRCCM Testing at Eglin AFB, and Acquisition and Tracking Field Tests Against Foreign Targets. Final hardware and software design reviews were conducted. The STINGER Block II Milestone II EMD Decision was supported by producing an IRFPA Seeker Design and prototype hardware to begin EMD.

Completed. 1999

SPONSORS

Army

JOINT WARFIGHTING SCIENCE AND TECHNOLOGY PLAN

COMPLETED DTOs

The Joint Warfighting S&T Plan (JWSTP) is structured around 12 Joint Warfighting Cabability Objectives (JWCOs) approved by the Joint Requirements Oversight Council. The following are the eight JWCOs that have had completed DTOs to date:

Information Superiority (IS) is the capability to collect, process, and disseminate an uninterrupted flow of information while exploiting or denying the adversary the same. It encompasses information warfare, which is the capability to affect an adversary's information, information-based processes, information systems, and computer-based networks while defending one's own information, information-based processes, information systems, and computer-based networks.

Precision Fires is the capability to neutralize selected targets efficiently and effectively, achieving the desired effects that contribute to, and can be linked directly to, the commanders' operational intent and schemes of maneuver, while limiting collateral damage.

Combat Identification (CID) is the capability to differentiate potential targets as friend, foe, or neutral in sufficient time, with high confidence, and at the requisite range to support weapon release and engagement decisions.

Military Operations in Urbanized Terrain (MOUT) is the capability to operate and conduct military operations in the urban battlespace and to achieve military objectives with minimum casualties and collateral damage.

Joint Readiness and Logistics is the capability to enhance readiness and logistics for joint and combined operations. It supports the enablers required to deploy and sustain the joint force across the full spectrum of operations.

Force Projection/Dominant Maneuver is the capability for fast deployment and timely employment and maneuver of joint forces to rapidly dominate the full range of military operations.

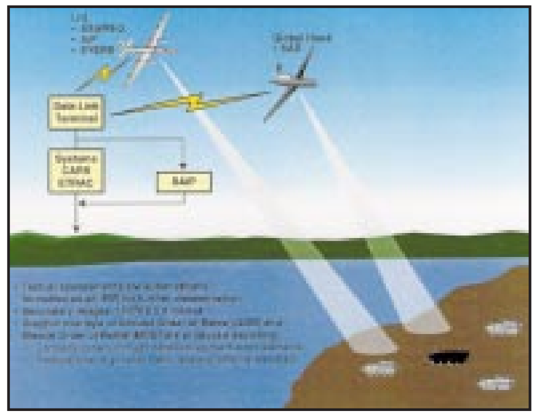
Electronic Warfare (EW) is the capability for deceiving, disrupting, and destroying the surveillance and command and control systems as well as the weapons of an enemy's integrated air defense network and the capability for recognizing attempts by hostile systems to track and engage.

Chemical/Biological (CB) Warfare Defense and Protection is the capability to detect and evaluate the existence of a manufacturing capability for weapons of mass destruction (WMD), and to identify and assess the weapon capability of alert and launched WMD on the battlefield to permit the appropriate level of counterforce and force protection to be executed promptly..

JOINT WARFIGHTING S&T PLAN

SEMIAUTOMATED IMAGERY PROCESSING ACTD (A.09)

Background. Semiautomated Imagery Processing (SAIP) is a system of integrated image exploitation software tools and associated hardware, designed to preprocess imagery from airborne platforms and cue image analysts to potential exploitable events. SAIP provides the image analyst with the tools needed to rapidly and accurately analyze high-volume surveillance imagery, and permits the rapid generation of reports and image products in support of the warfighter. SAIP brings together template-based SAR automatic target recognition, cluster analysis, object-level change detection, interactive target recognition, electro-optic (EO) and SAR site monitoring, and force structure analysis to provide commanders with greatly improved situation awareness.



Success. The capabilities of planned imagery collection assets will provide more than an order of magnitude more imagery than that provided by current platforms, and at higher resolutions. The Global Hawk UAV, for example, can provide some 1,900 SAR spot images per day at 0.3-m resolution. Current exploitation systems will be incapable of handling this great increase in imagery volume and rate. SAIP provides the necessary automation technologies to assist in processing these larger volumes of broad-area coverage imagery. SAIP makes imagery intelligence a much more responsive resource for the tactical commander, thus enabling dominant battlespace awareness by focusing theater and tactical sensor exploitation, tactical surveillance, and site monitoring on critical, timely intelligence requirements.

Field tests of SAIP commenced in March 1997 with the XVIII Airborne Corps using the Enhanced Tactical Radar Correlator ground station as an interface to SAIP. There were several subsequent successful evaluations during field exercises, culminating with a Military Utility Assessment conducted at the National Training Center (NTC) rotation 99-04 in January and February 1999. The assessment was conducted by U.S. Atlantic command (USACOM) and the USAF Operational Test and Evaluation Center, and assessed the SAIP contribution to the commander's overall battlespace picture in context of multisensor operations. SAIP demonstrated the ability to process real-time downlinked imagery and process Global Hawk SAR imagery from the DARPA Sensor Emulation Platform (SEP). The XVIII Airborne Corps After-Action report stated that SAIP deserved "high marks for its ability to give the combat commander a snapshot that allows him to quickly comprehend the situation." Significant decreases in reporting times were demonstrated, providing value-added to targeting. Significant value-added was found for detection of targets, false alarm mitigation, and force structure analysis. Further, automated generation of annotated image products allowed image analysts (IAs) using SAIP to be significantly faster on average than unaided IAs. System residuals were provided to the Army and Air Force in FY99, and a Joint Project Office (JPO) was set up. The Army SAIP residual is currently preparing for deployment, and the Air Force residual is being integrated into the Deployable Ground Station. Continued SAIP development has been supported in the FY01 Defense budget.

Completed. 1999

SPONSORS

OSD
DARPA

NAVIGATION WARFARE ACTD (A.16)

Background. The Navigation Warfare (NAVWAR) ACTD was initiated in response to needs identified in a U.S. Air Force Science Advisory Board study, "Global Positioning System Survivability and Denial," in November 1993, and in a Defense Science Board Task Force, "Global Positioning System," in November 1995. The desire was to prevent the use of satellite-based navigation by hostile forces and to protect the use of the GPS by U.S. and friendly forces, without disturbing the use of GPS outside of the theater of conflict. The ACTD was initiated in 1996 and led by the GPS JPO. The Joint Forces Command (JFCOM) was the sponsoring commander-in-chief (CINC) and provided the Operational Manager and demonstration venues for the program.

Success. The NAVWAR ACTD developed first-generation prevention (GPS jammers) and protection (antijam) equipment and demonstrated this equipment in the field. Three types of jammers were developed, including small expendable jammers the size of a soda can, jammers for mounting on trucks (High Mobility Multipurpose Wheeled Vehicles) and jammers for mounting on aircraft (NKC-135s and helicopters). Two types of protection equipment were developed. The first was a dual-frequency, enhanced-reacquisition version of the Precise Lightweight GPS Receiver and a version of the avionics used in aircraft that could acquire the GPS military code directly without starting with the more vulnerable course acquisition code. Most important, the use of this equipment in five major exercises and a half dozen smaller demonstrations clearly showed the disruption and confusion caused by GPS jamming, the need for GPS training, and the need to include GPS jamming in military exercises in the future. The CONOPS and procedures for GPS jamming in exercises were established. In addition, this ACTD was one of the catalysts in the establishment of an operational requirements document (ORD) for navigation warfare, which the Air Force is planning to submit to the Joint Requirements Oversight Council in FY01. Thirty-five of the GPS Receiver Applications Module avionics cards developed for the ACTD were diverted to the GBU-15 program in support of Operation Allied Force. Following the ACTD, the 746th Test Squadron at Holloman AFB retains the equipment, and JFCOM retains operational control of the contingency go-to-war residual capability of the equipment. These assets will be employed in the Joint GPS Combat Effectiveness Joint Test and Evaluation early in FY01. Development of more advanced prevention and protection equipment continues.

Completed. 1999

SPONSORS

OSD
Air Force

JOINT TASK FORCE ATD (A.17)

Background. The Joint Task Force (JTF) ATD was a pioneering program in the field of distributed, collaborative computing. In a typical JTF command hierarchy, the critical people, relevant data, and their supporting computers are geographically distributed across a wide area network. This causes many problems that would not exist if they were all in the same location. The goal of JTF ATD was to make it easier for people to work together. A system that facilitated the sharing of data and ideas without compromising security, timeliness, flexibility, availability, or other desirable qualities was needed. After experimentation with numerous architectures and implementations, JTF ATD came to the conclusion that an enterprise solution to data dissemination and access was needed. It also became apparent that the different types of data needed to support JTF missions were as ubiquitous as the missions themselves. Therefore, planning systems would need the ability to associate previously unknown data elements to their plan composition. A distributed, object-oriented design held the most promise to meet these goals.

Success. Unfortunately, building distributed, object-oriented data servers with the complex infrastructure to support enterprise solutions was costly and time consuming. JTF ATD built the Next Generation Information Infrastructure (NGII) tool kit to address this problem. The NGII tool kit allows developers to code-generate object-oriented data servers in days rather than months. The NGII code generator synthesized complex code dealing with concurrency, replication, security, availability, and persistence for each server, thus ensuring that all servers followed the same enterprise rules. The NGII tool kit and its descendants are widely used by many projects today to help generate distributed, object-oriented servers with the intelligence to act in concert across the enterprise.

Completed. 1999

SPONSORS

DARPA

RAPID FORCE PROJECTION INITIATIVE COMMAND AND CONTROL TD (A.22)

Background. The objective of the Rapid Force Projection Initiative (RFPI) Command and Control Technology Demonstration (C2 TD) was to demonstrate a semiautomated forward sensor to weapon-system target-transfer capability for the early entry light-insertion force. The linkage of sensors to shooters was fully integrated with the C2 elements of a light force brigade, resulting in shortened sensor-to-shooter timelines, increased lethality, increased survivability, and greater synchronization of battle.

Success. The RFPI C2 TD developed and delivered a Light Digital Tactical Operations Center (LDTOC), a LDTOC Simulator, Distributed C2 software, a Communications Processor software package, and three digitally equipped vehicles of the Brigade Tactical Command Post, as well as providing enhanced connectivity between Tactical Operations Centers (TOCs) using the Maneuver Control System. The C2 TD LDTOC was incorporated as part of the RFPI ACTD for its final full-field exercise during the last quarter of FY98. The digital C2 system networked three new sensor systems and three new weapons (killer) systems under the hunter/standoff killer (HSOK) concept in enabling a brigade of the 101st Air Assault Division to defeat a reinforced heavy armor division during the final RFPI ACTD demonstration at Fort Benning, GA.

Completed. 1998

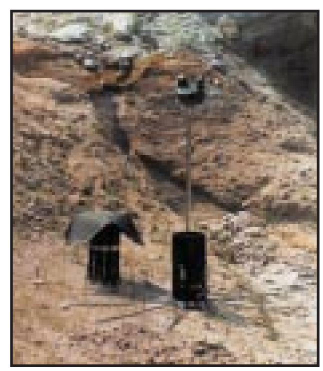
SPONSORS

Army
Navy

UNATTENDED GROUND SENSORS ACTD (A.24)

Background. The Unattended Ground Sensors (UGS) ACTD began in FY98 in response to identified operational needs from the Joint Staff, Central Command (CENTCOM) and Special Operations Command (SOCOM). The Joint Staff and CENTCOM requirement was to detect and prosecute time-critical targets such as SCUD launchers. The needs of SOCOM focused on localized and timely weather reporting. The Central Measurement and Signature Intelligence (MASINT) Organization served as the executive agent for the ACTD; CENTCOM and SOCOM were the operational sponsors; the U.S. Air Force was the lead service and has responsibility for the transition of this technology to operational use. The demonstration period was completed in August 1999 and the ACTD entered its interim capability period immediately thereafter.

Success. The UGS ACTD developed and demonstrated two unattended sensors, Unattended MASINT Sensors (UMS) and the Remote Miniature Weather Station (RMWS). Both have hand-emplaced and air-delivered versions. UMS utilized acoustic/seismic techniques to detect, identify, locate, and report time-critical, mobile targets. RMWS was developed to measure and report local weather conditions in denied areas. The sensors all report information using satellite communications. The UGS ACTD participated in several field tests, demonstrations, and operational exercises during the two-year demonstration period. Both UMS and RMWS received favorable military utility assessments. RMWS entered an acquisition program in FY01, while UMS will enter acquisition in FY02. The UGS ACTD sensors were requested for use during Operation Allied Force in the spring of 1999, and RMWS was eventually used by United States Air Forces in Europe during the operation and continues to be use in Theater. RMWS is part of the Air Force's OS-21 acquisition program for operational weather sensors, with funding beginning in FY01. The Air Force renamed UMS as the Advanced Remote Unattended Ground Sensor (ARGUS), approved an operational requirements document, and included the ARGUS program in the Tab P portion of their FY02 Program Objective Memorandum. The U.S. Army Intelligence Security Command also developed a UMS derivative to satisfy their mission needs. Without the support of the ACTD program, neither UMS nor RMWS would have transitioned to acquisition so rapidly. Additionally, the demonstration period enabled both the operational users and acquisition agents to become familiar with the sensors and recommend value-added improvements early in the development process.

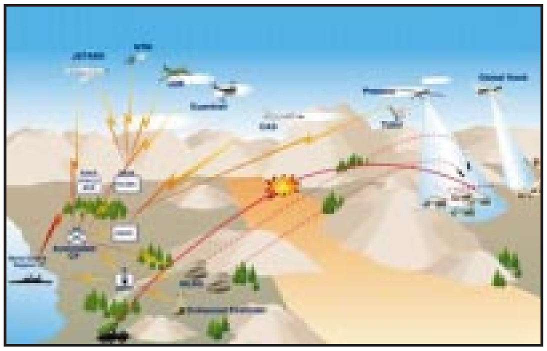


Completed. 1999

SPONSORS

OSD
DIA

PRECISION/RAPID COUNTER MULTIPLE ROCKET LAUNCHER ACTD (B.01)



Background. The Precision/Rapid Counter Multiple Rocket Launcher (P/RCMRL) ACTD was initiated at the request of U.S. Forces Korea to counter the threat posed by the 240-mm Multiple Rocket Launching Systems (MRLS) and 170-mm long-range guns possessed by North Korea. These threats can reach Seoul from their garrison locations just north of the Demilitarized Zone. The threat is housed in hardened underground shelters and the launchers and guns are only exposed when they are in firing locations. This exposure time is very short. The ACTD was initiated in 1995 and led by the Joint Precision Strike Demonstration office with support from the Deep & Simultaneous Attack Battle Laboratory, Fort Sill. The operational unit in Korea is the 2nd Infantry Division (2ID) which is charged with defeating this threat. The assets left with the 2ID include an automated division main command post and a tactical command post.

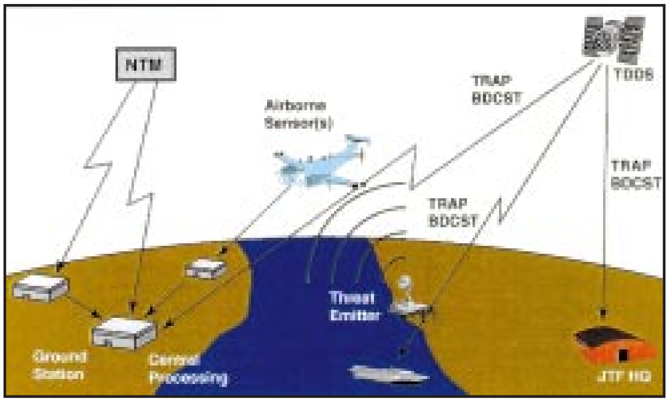
Success. The ACTD implemented a new C2 architecture for the 2ID which met the timelines imposed by the threat. An initial improvement in effectiveness for the 2ID was achieved by changes in their concept of operations even before the material solution was introduced. The ACTD implemented a new Wide Area Net into the 2ID and then installed C2 software for both reactive and proactive fires. The reactive fires utilize radar detection and tracking to locate exposed launchers and the proactive fires utilize sensors on unmanned aerial vehicles and other platforms to detect targets. The C2 functions were implemented using the Advanced Deep Operations Coordination System (ADOCS) software originally developed by DARPA. Fire missions developed with the help of ADOCS are sent to Army MRLS units, to Air Force aircraft and to naval ships, depending on the availability of weapons and the estimated target exposure times. The reactive fires, using MRLS, met the extremely short timelines of the threat exposure. The proactive timelines are typically longer and that allows other weapons to be effectively brought to bear. The systems that were introduced into Korea in 1996 are standing watch with the 2ID today. The ADOCS approach to coordinated joint deep fires has been so successful that this software package continues to evolve in response to CINC needs and is now used by all three services in Korea, Europe, and CENTCOM. Two major demonstrations were conducted, one CONUS-based and the other in Korea. The final demonstration, completing P/RC MRL's military utility assessment, was concluded during the fourth quarter of FY96.

Completed. 1998

SPONSORS

OSD
Army

PRECISION SIGNALS INTELLIGENCE TARGETING SYSTEM ACTD (B.03)



Background. The Precision Signals Intelligence (SIGINT) Targeting System (PSTS) ACTD was initiated at the request of U.S. Forces Korea to accurately geolocate certain radar emitters in a timely manner. The desire was to directly target the radar based on this information. The requirement to directly target the radar determined the necessary accuracy and timeliness of the measurements, communications, and processing needed to generate the geolocation results. The program was initiated in 1995 and led by the Office of Naval Research (ONR). ONR was supported in this ACTD by the Defense Airborne Reconnaissance Office, the National Reconnaissance Office, the National Security Agency, the U.S. Army Intelligence and Security Command (INSCOM), and the 501st Military Intelligence Brigade (Korea).

Success. The ACTD met the required timeliness and accuracy goals and continues in a limited operational status. To achieve these goals, the U.S. Army Guardrail system was modified to generate precision SIGINT measurements and to coordinate these measurements with SIGINT from other collectors. Communications paths were established to coordinate the collections and to transmit the resulting SIGINT data for processing. Software was developed to combine these measurements to yield the precision geolocations. The results were sent to users through normal intelligence data dissemination channels. The capability was demonstrated in live-fire exercises where radar emitters were successfully attacked by artillery and aircraft based on the location data determined from the combined SIGINT data from multiple platforms. Following the successful demonstration and limited operational capability of the PSTS ACTD, the multiagency Airborne Overhead Integration Office was established to transition the technology into a fully operational capability.

> **"The Precision SIGINT Targeting ACTD shows great promise for warfighters."**
>
> *– Major General Noonan, Commander, U.S. Army Intelligence and Security Command*

Completed. 1998

SPONSORS

OSD
Navy

TARGET ACQUISITION ATD (B.05)

Background. The Target Acquisition (TA) ATD was designed to integrate a multi-sensor suite into a combat vehicle environment in order to demonstrate an increase in the acquisition range to targets and to automate the acquisition process so that time-lines are decreased as compared to manual acquisition timelines. The results of the ATD were used as part of the baseline sensor requirements for the Future Scout/Cavalry System ATD. In addition, product improvement candidates for modification of the electronic design of the second-generation FLIR may be pursued by the Program Manager-Night Vision/Reconnaissance, Surveillance, and Target Acquisition (PM-NV/RSTA). The most challenging technical barrier has been the integration and operation of a complex, multitasking, automated wide-area search mode. A secondary technical challenge was the integration of a multiple-function laser in the same physical envelope as the currently fielded Nd:YAG laser on the M1A2 Abrams Main Battle Tank.

Success. The TA ATD has demonstrated the extension of the acquisition range over the baseline established in the exit criteria by increasing the aperture size of the optical system used on the second-generation FLIR. A crucial component of the system is the Multifunction Laser System (MFLS), which provides a 10 x 20 (200 shot) laser profile of any target, with direct output to the TA ATD Aided Target Recognition algorithm. To date, the MFLS has exceeded its requirements by ranging in excess of 5 km and profiling targets in excess of 4 km. The Millimeter Ground Radar, a 35-GHz moving target indicator, has also been completed and has tracked up to 20 targets simultaneously, under a variety of environmental conditions. The TA ATD system has been integrated onto the host vehicle (M113 Armored Personnel Carrier).

Completed. 1998

SPONSORS

Army

HUNTER SENSOR SUITE ATD (B.09)

Background. The Hunter Sensor Suite (HSS) ATD incorporates the ultimate in high-performance, second-generation scanning FLIR technology. The HSS system successfully completed incorporation with the Rapid Force Projection Initiative (RFPI) ACTD during its final demonstration at Fort Benning in FY98. As one of the three sensor technologies under evaluation during the final demonstration, it enabled a brigade of the 101st Air Assault Division to defeat a reinforced heavy armor division. As a result, both HSS systems were decleared "go to war" capable by the 101st and remain in operarational residual status. The two HSS systems were chosen to remain with the 101st for a two-year residual period (FY99–00). The CECOM Night Vision and Electronic Sensors Directorate (NVESD) managed the HSS ATD.

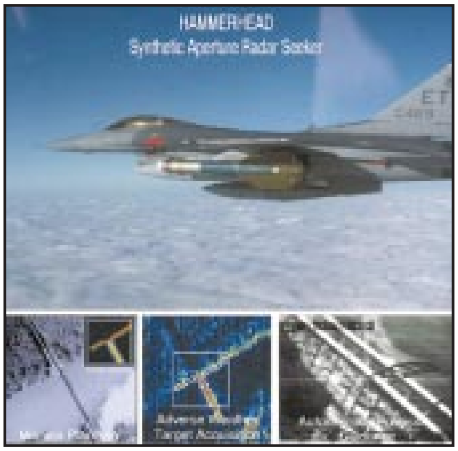
Success. The following technical capabilities were demonstrated during the ATD and RFPI ACTD: long-range target detection and discrimination with integrated ATR; precision target location determination; still-image transmission using Lightweight Video Reconnaissance System; on-the-move target acquisition capabilit; telescopic-mast-mounted sensor suite; acoustic detection and cueing; and system interface to distributed command and control applique. These technologies allow the warfighter to quickly find multiple targets at long ranges, determine accurate targeting coordinates, and then hand off this information efficiently with increased survivability.

Completed. 1997

SPONSORS

Army

HAMMERHEAD ATD (B.22)



Background. The Hammerhead program, conducted by the Munitions Directorate of the AFRL, set out to evaluate the applicability of low-cost SAR seeker technology to precision munitions. The Navy and Air Force JDAM program offices participated in the Hammerhead program. Other programs expressing interest in the Hammerhead program include the Joint Air-to-Surface Standoff Missile, AGM-130/GBU-15, Tomahawk cruise missile, and the Hard and Deeply Buried Target Defeat program initiative.

Success. Hammerhead demonstrated the ability of an SAR seeker to achieve a CEP of less than 3 meters in adverse weather conditions, a significant advancement over current seekers which have limited use in adverse weather conditions. A major technical barrier, the ability of the SAR seeker to perform precision guidance in steep dive trajectories, was overcome by careful theoretical analysis and rigorous captive flight testing. This carried the SAR-guided munition through a significant portion of the steep dive trajectory. Obtaining precision velocity and acceleration measurements in a highly dynamic steep dive flight environment also proved to be a formidable challenge. Careful implementation of acceleration smoothing techniques and motion compensation software adequately addressed this challenge for the Hammerhead demonstrations. The SAR seeker technology under this program provides a revolutionary air-to-surface precision guidance capability in adverse weather, allowing for the success of fixed or stationary targets any time, anywhere, by Air Force attack and bomber aircraft. The Hammerhead approach addresses the need of the JDAM program to achieve a precision, adverse-weather weapon delivery capability for a high-altitude, direct-attack scenario. The activities on the Hammerhead program provided useful data on the component tolerances and system calibration processes. These data will be used to determine realistic cost and schedule estimates for future development programs and will provide valuable technical specifications for manufacturing.

Completed. 1999

SPONSORS

Air Force

BATTLEFIELD COMBAT IDENTIFICATION ATD (C.01)

Background. The Battlefield Combat Identification (BCID) ATD was formed to address the problem of fratricide, or casualties from friendly fire. In every hostile action since World War I, U.S. forces have recorded major incidents of fratricide. Many aspects of modern warfare (e.g., night operations by highly mobile forces, coalition campaigns) complicate combat effectiveness without also decreasing the risk of losses due to fratricide. Operation Desert Storm underscored the need to develop effective and survivable Combat Identification (CI) capabilities to minimize fratricide. As an outgrowth of, and in conjunction with, this ATD, a Joint Combat Identification (CID) ACTD was formed to extensively investigate an affordable, effective, and survivable CI architecture. The primary objective of the ATD was to accelerate and facilitate application of mature advanced technologies to solve key issues and provide new operational capabilities that will make a difference to the warfighter. This new CI architecture allows for the integration of the two most deficient CI mission areas: ground-to-ground and air-to-ground (A-G). Capabilities encompass situational awareness (SA), target identification (TI), and their integration. This dual approach to CI uses SA and positive, immediate TI as synergistic solutions for increasing combat effectiveness while minimizing fratricide on future battlefields.

The key players in the ATD included NVESD, the Dismounted Battle Space Battle Lab (DBBL), TRADOC, TPIO, TRAC-WSMR, and AMSAA. In addition, through the Joint CI ACTD, other agency participation included: AFOTEC-TA, JITC, JC2WC, TEXCOM, JCIDO, AF CID, ANG Test Center, NAVSPACOM, MARCORSYSCOM, and JBC. Product Manager, Combat Identification, completed the BCID ATD.

Success. Technologies analyzed encompassed Systems That Point, "Don't Shoot Me" Systems, Situational Awareness Systems, and Non-Cooperative Target Recognition Systems. All of the technologies being considered participated in at least one of the following demonstrations/exercises: Virtual Integration Experiment, Combat ID Exercise, Combat ID Interoperability Demo, ASCIET-96; TF-XXI; JWID-97; JTFEX-9702; the 4-Nation International Demo; and three different DBBL Warfighting Experiments.

Technologies that were transitioned from this effort and the CID ACTD were the Battlefield Combat Identification System (BCIS), Situational Awareness Data Link (SADL), and the Combat ID Dismounted Soldier (CIDDS). BCIS is going to the 4ID and III Corps as part of the Digitized Division and Corps, while SADL is being outfitted in all Air National Guard/Reserve CAS F-16 aircraft. CIDDS is slated to eventually be part of the Table of Organization and Equipment (TOE) of all Category 1 units; its initial fielding will most likely be to either the 82nd Airborne or 10th Mountain Divisions.

Completed. 1998

SPONSORS

Army

JOINT COMBAT IDENTIFICATION ACTD (C.02)

Background. Combat identification is a critical requirement for the battlefield of the future. It is recognized that the highest military payoff is achieved through positive hostile identification. If this cannot be achieved to the required degree of performance under all battlefield conditions, it will be necessary, at least, to ensure that friendly forces are not engaged. Additionally, the engagement of neutrals should be minimized. Therefore, a combination of noncooperative systems, cooperative systems, and improved use of situational awareness should be employed simultaneously on the future battlefield in a variety of implementations, depending on weapon system requirements and economic constraints.

Success. The Joint CID ACTD provided a mechanism to improve the most deficient combat identification mission areas: air-to-surface and surface-to-surface combat identification of hostile forces. CID's dual approach of improving situational awareness and positive, immediate target identification provided synergistic solutions for increasing combat effectiveness while minimizing fratricide on future battlefields. Concurrently, the CID ACTD enabled refinement of Joint/Service CID tactics, techniques, and procedures (TTPs) and CONOPS. Numerous units of the Army, Marine Corps, Air Force, Navy, and Air National Guard participated in the operations and assessment of this ACTD. The military utility of 14 different systems and approaches was assessed for their capabilities to identify ground platforms from other ground vehicles, fixed-wing aircraft, Forward Air Controller, and rotary wing aircraft. Two of the 14 technologies were assessed as immediately useful for operational employment: the U.S. Army BCIS for vehicle-to-vehicle identification and the Air National Guard SADL for Close Air Support (CAS) aircraft-to-vehicle identification. Success of this ACTD directly supported the transition of both efforts. A FY99 low-rate initial production (LRIP) contract was awarded for 2,620 BCIS units to be procured in the FY99-05 timeframe, with fielding beginning in FY02. Additionally, SADL began fielding to Air National Guard F-16 aircraft in FY98. The Single Channel Ground and Airborne Radio System - System Improvement Program Plus demonstrated great potential in the rotary wing-to-ground vehicle mission area and was transitioned to the Army technical base for further improvements.

Completed. 1998

SPONSORS

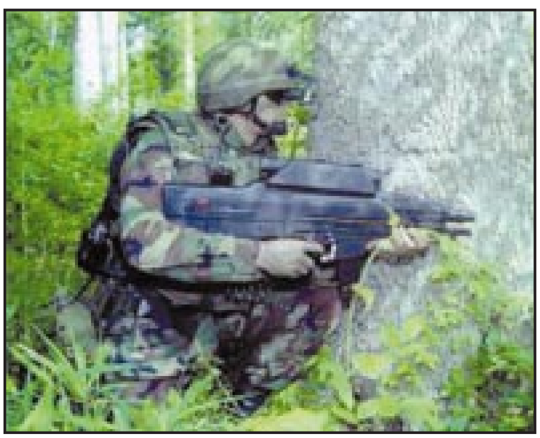
OSD
Army

OBJECTIVE INDIVIDUAL COMBAT WEAPON ATD (E.03)

Background. The Objective Individual Combat Weapon ATD has demonstrated the potential to significantly increase the lethality of our dismounted combat soldiers with a concomitant dramatic increase in their survivability. This TD demonstrated a shoulder-fired weapon with a 20-mm fragmenting projectile capable of airbursting at a target location. The system offers the potential of a 300-500% increase in effectiveness over the baseline M16 series of rifles, and the ability to defeat targets well beyond the effective range of threat systems. The system also allows for the defeat of targets hidden in foxholes and behind obstacles, a capability the current system does not have.

Success. This program has evolved technology across a broad spectrum of disciplines. In the area of fuzing, a miniature 20-mm electronic fuze and safe and arm device was developed to airburst the projectile at the appropriate time. A method to count turns of the projectile in lieu of time was developed to compensate for muzzle velocity variation. Sophisticated electronic fire-control technology has been taken to the small arms platforms. Laser range finders, opto-electronic displays, thermal sensors, a target tracker, environmental sensors, and a ballistic computer have all been integrated into the system concept. The technology of the weapon itself has been advanced in the areas of recoil mitigation and inductive fuze setting. For the first time, wiring and electrical connectivity to the soldier system have been included in the concept design.

The program developed a complete immersive interactive simulation of the concept to help refine the design and to assess the system performance with troops. Constructive force and force-on-force and vulnerability models were modified to validate the potential of the concept system and to justify the requirements. The ATD program culminated in the building of representative systems for engineering and performance evaluation and ultimately live-fire early user evaluations. Extensive use of formally trained and empowered teams streamlined and facilitated the process. The success and lessons learned from this ATD will form the baseline for future programs.



The ATD has advanced the technology available for our future soldiers, has designed and developed a demonstration weapon concept, and has validated the potential of such a future weapon concept. As a result, the user has approved an Operational Requirement Document for the concept. Developed by the Army's Tank-automotive & Armaments Command, Armament Development and Engineering Center, the program was transitioned to the Army's Program Manager for Small Arms, also part of the Tank-automotive & Armaments Command, who expects to field the new system in FY09. The success of this ATD has set the stage for and redefined the next generation small arms weapons systems.

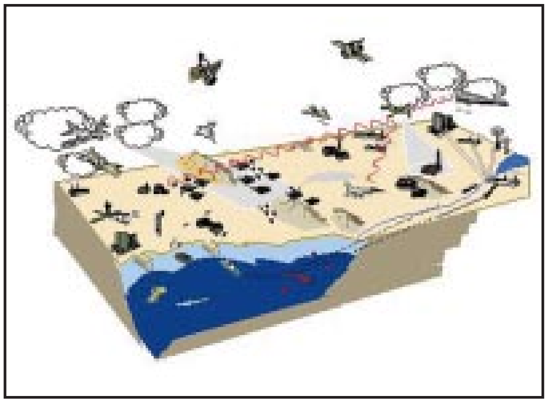
Completed. 1999

SPONSORS

Army
Marine Corps

SYNTHETIC THEATER OF WAR ACTD (F.01)

Background. The Synthetic Theater of War (STOW) ACTD developed and evaluated the capabilities of Advanced Distributed Simulation to improve joint training, mission rehearsal, and experimentation. STOW demonstrated that advances in computer technology, networking, and computer-generated forces make it possible to create a virtual battlefield, representative of any location in the world. Warfighters can populate it with intelligent synthetic forces operating within an interactive natural environment and then interact with the simulation from distributed locations across the country using a simulation network.



Success. The STOW ACTD may be measured by successes in three areas: Advances in Technology; Operational Use; and Transition. With DARPA as the technology developer, the STOW simulation advanced the state of the art in computer-generated forces, synthetic natural environments, networking, and after-exercise analysis. Successful operational examples include STOW being utilized by USACOM for joint training, by the Marines for mission rehearsal, by the Air Force in the Distributed Mission Training Program, by the Army for training and concept exploration, by the Navy for Fleet Battle Experiments, and by the U.S. Joint Forces Command for Joint Experimentation. STOW was the lead simulation system for Attack Operations 00 and will drive planned experiments from 2001–2004. Transition of the STOW technology, tools, and applications has occurred to all Military Services, the United Kingdom, U.S. Joint Forces Command, the next generation of DoD simulations, and many industry users. STOW is now maintained and managed by the U.S. Joint Forces Command, J95, and copies of the simulation software will be provided, as requested, to any DoDe project.

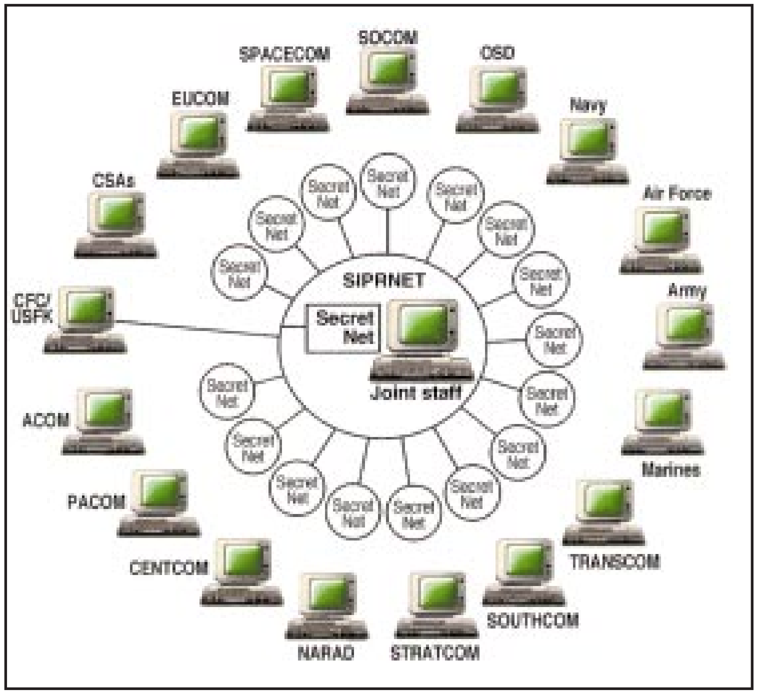
Completed. 1998

SPONSORS

OSD
DARPA

ADVANCED JOINT PLANNING ACTD (F.02)

Background. The objective of the Advanced Joint Planning ACTD was to provide USACOM, Joint Staff, and other CINCs with an increased ability to rapidly plan, package, and deploy forces to manipulate regional conflicts. This program adapted the technologies developed by the JTF ATD (e.g., architecture, application, servers, schema) and other DARPA initiatives for configuration into USACOM's command, control, communications, and computers (C4) environment.



Success. The Advanced Joint Planning ACTD, including the Joint Readiness Extension, developed and demonstrated a capability to integrate, organize, analyze, and present joint readiness data for all CONUS-based forces. It also provided a comprehensive set of distributed planning tools for mission planning, course of action development and evaluation, and logistics and transportation assessment. Some of the software tools from this ACTD have been operational at U.S. Joint Forces Command (USJFCOM) for almost two years, and have resulted in a reduction of planning times between the CINC and his components from a period of approximately seven days to several hours. Most of the tools from Advanced Joint Planning have been incorporated into the GCCS.

For example, the TPEdit tool provides the ability to graphically manipulate deployment plan data. It has been demonstrated by USPACOM and USTRANSCOM to reduce plan development time fivefold. The TARGET tool has demonstrated distributed, dynamic courses of action development by CINC staffs. It is currently deployed at USPACOM and is the web-based planner for GCCS 4.0. The Joint Readiness Automated Management System (JRAMS) tool demonstrated Total Force Readiness Assessment to carry out multiple theater operations plans. It has been used by USPACOM, USJFCOM, and USEUCOM for the past three years.

Completed. 1998

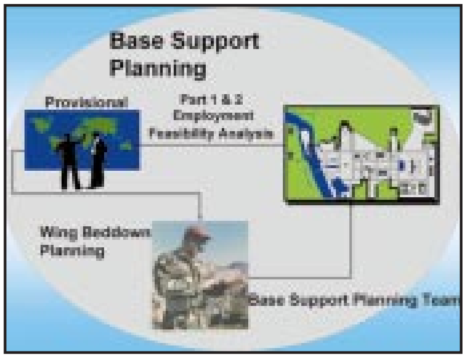
SPONSORS

OSD
DARPA

LOGISTICS TECHNOLOGIES FOR FLEXIBLE CONTINGENCY DEPLOYMENTS AND OPERATIONS (F.16)

Background. The Logistics Capability Assessment Tool (LOGCAT) program began in 1995 as an integrated suite of logistics command and control applications developed in conjunction with Air Staff planners, local contractors, and major command (MAJCOM) functional representatives. Using a combination of COTS and government proprietary products in its design, the LOGCAT team developed several proof-of-concept software programs. These tools were designed to interoperate with existing legacy systems in the Secret Internet Protocol Routing Network environment. The Joint Chiefs of Staff J-4 have seen program demonstrations, and the programs have been targeted for possible further joint development and implementation.

Success. LOGCAT is a suite of automated decision support tools for crisis action planning across all levels of command in logistics command and control. Through reduced response planning time, execution cycle, deployment footprint, work-hours, and time to deploy at the wing level, these tools support the Air Force Core Competencies of Agile Combat Support and Rapid Global Mobility as well as providing proactive identification of logistics-related, mission-critical limiting factors. These technologies aid today's and tomorrow's deployment and beddown planners at the CINC of unified commands, JTF, Joint Forces Air Component Commander, Air Force Forces, Numbered Air Force, Wing, and Unit levels worldwide.



LOGCAT was rapidly deployed supporting the U.S. Air Force Europe (USAFE) Kosovo operations. Within 48 hours, a combined LOGCAT team of AF/ILXX, AFRL, and primary contractors was dispatched and successfully set up a stand-alone prototype at Ramstein Air Base, Germany, in the USAFE/LG vault. This enabled critical airfield site survey information to be collected and stored, providing the capability to perform beddown feasibility assessments in support of current operations.

Three components of the LOGCAT suite (Survey Tool for Employment Planning, Beddown Capability Assessment Tool, and the Employment Knowledge Base) have already transitioned to the Air Staff sponsor, AF/ILXX, and Standard Systems Group at Gunter AFB, Alabama, for full operational production and worldwide implementation. A fourth component of LOGCAT, the Logistics Analysis to Improve Deployability, shows opportunity for improving the base level deployment process and will be incorporated by Air Staff into Air Force deployment instructions and policy.

Several high-visibility joint and service-unique war games/experiments such as Global Engagement '98, '99, and Expeditionary Forces Experiment '98, '99 have tested the LOGCAT tools as primary logistics inputs. The tools were so successful that they were selected as the Agile Combat Support infrastructure and baseline for Joint Expeditionary Forces Experiment '00 and beyond.

Completed. 1999

SPONSORS

Air Force

VEHICULAR-MOUNTED MINE DETECTOR ATD (G.02)

Background. There were five systems participating in this ATD. Features common to all systems include 3-meter-wide detection coverage, integrated GPS, physical marking of detection locations, electronic storage of detection, locations/geolocation of detections, and ATR algorithms. During tests, each system covered an area of 21,000 m^2, encountered 770 targets, and had approximately 12,000 false alarm opportunities.

Success. This ATD demonstrated the capability to detect and mark surface-laid and buried mines from a vehicle-mounted platform through development of new sensors and by integrating sensor fusion and automatic mine recognition techniques. The primary achievements of this ATD included development of the mechanism to distinguish mines from clutter, and the capability to operate in diverse environments, terrain, and soils at maneuver speed. The ability to detect and mark anti-tank mines in stride contributes significantly to the commander's ability to maintain freedom of maneuver and to control the operational tempo.

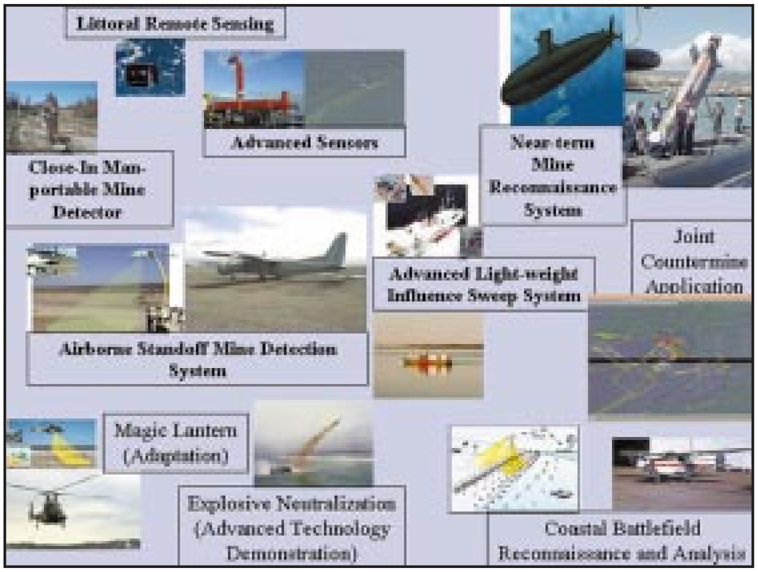
Completed. 1998

SPONSORS

Army

JOINT COUNTERMINE ACTD (G.04)

Background. This DTO evaluated the utility of new technologies to enhance a Joint Task Force Commander's ability to conduct seamless, amphibious, mine countermeasures operations from sea to land. The Joint Countermine (JCM) ACTD integrated 13 novel systems for both detecting and clearing mines and minefields. These novel systems were integrated with operational countermine systems under an umbrella including a command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR) architecture using a JCM Application (JCA) software for a JCM common operational picture, and a JCM Operational Simulation system.



Success. Two major demonstrations were conducted in conjunction with a JTF exercise (JTFEX 97-3) in FY97 and a NATO exercise (MARCOT/Unified Spirit 98) in FY98. Several of the JCM systems participated in additional operational exercises over the ensuing two-year interim capability period of the JCM ACTD. A number of the novel systems that participated in the JCM ACTD have successfully transitioned to acquisition programs. Specifically, Coastal Beach Reconnaissance and Analysis, Littoral Remote Sensing, and JCA have made a direct transition. Some systems have a more indirect transition path. For example, the Close-in Man-Portable Mine Detection System has transferred technology and operational lessons learned to the Handheld Stand-off Mine Detection System, currently in initial Engineering and Manufacturing Development. The Navy's Advanced Sensor program transitioned the Electro-optic Identification and Synthetic Aperture Sonar programs. The Advanced Light-Weight Influence Sweep System technology is being considered with further development for the OASIS program, and Magic Lantern (Adaptation) technology is a candidate for the Airborne Laser Mine Detection System program. The Near-term Mine Reconnaissance System program has been restructured to support Long-term Mine Reconnaissance System development. Three systems, which demonstrated minimal military utility during the JCM ACTD, were terminated following the JCM ACTD. They are the Joint Amphibious Mine Clearance System, the Off-Route Smart Mine Clearance, and Power Blade. The customer for this DTO is Joint Forces Command.

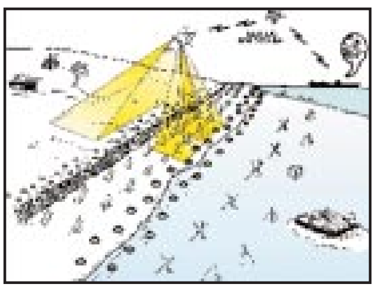
Completed. 1998—Residual period ended FY00.

SPONSORS

OSD
Army
Navy

RAPID BATTLEFIELD MINE RECONNAISSANCE (G.05)

Background. The Rapid Battlefield Mine Reconnaissance DTO demonstrated coastal area reconnaissance in beach zone, craft landing zone, and inland areas using advanced passive optical sensors in a UAV. The DTO focused on Coastal Battlefield Reconnaissance and Analysis (COBRA). COBRA incorporates advanced multispectral sensors and optics in a Pioneer UAV for daylight countermine reconnaissance.



Success. This DTO demonstrated coastal area reconnaissance in beach zone, craft landing zone, and inland areas using advanced passive optical sensors in a UAV. It included dual advanced multispectral video cameras, forward-looking video, and video downlink ground station processing with real-time tracking and map overlay. Pioneer flew more than 300 missions and 1,300 hours during Desert Storm with only one operational loss. The following DTO technology objectives were demonstrated in the Joint Countermine ACTD: 0.8 probability of minefield detection; 0.3 probability of minefield false alarm; 50-meter swath width at 880 feet altitude; 60–100 knots airspeed; and improved near–real-time processing. The capability demonstrated in the DTO provides the Commander, Joint Task Force (CJTF) with an ability to conduct rapid minefield reconnaissance of a coastal area using a highly survivable UAV. It provides information that will significantly aid in planning for amphibious operations. G.05 was demonstrated as part of the Joint Countermine ACTD in June 1998, wherein it detected and characterized minefields at two separate beaches and an inland area. The technology was transitioned for advanced development to its customer, PM C4I-MARCORSYSCOM in June 1998.

Completed. 1998

SPONSORS

Marine Corps

AUTONOMOUS SHALLOW-WATER INFLUENCE SWEEPING (G.07)

Background. This DTO demonstrated the ability to successfully conduct remote influence sweeping of magnetic and acoustic mines targeted against amphibious assault craft in shallow and very shallow water. It included a conductively cooled, low-temperature, superconducting magnet for magnetic sweeping and plasma-discharge pulse power for acoustic sweeping. The technology objectives of this DTO were met. The capability demonstrated in the DTO provides high-speed influence minesweeping of intended amphibious assault lanes in shallow and very shallow water.

Success. This will support the CJTF by addressing the emerging mine threat, decreasing the number of platforms required for amphibious assault sweeping, and increasing personnel and equipment survivability during amphibious assaults. DTO G.07 was demonstrated as an integrated system in the JCM ACTD Demo II in June 1998. The Advanced Lightweight Influence Sweep System (ALISS) magnetic subsystem will transition to PMS-210 Shallow Water Influence Mine Sweep in FY00.

Completed. 1998

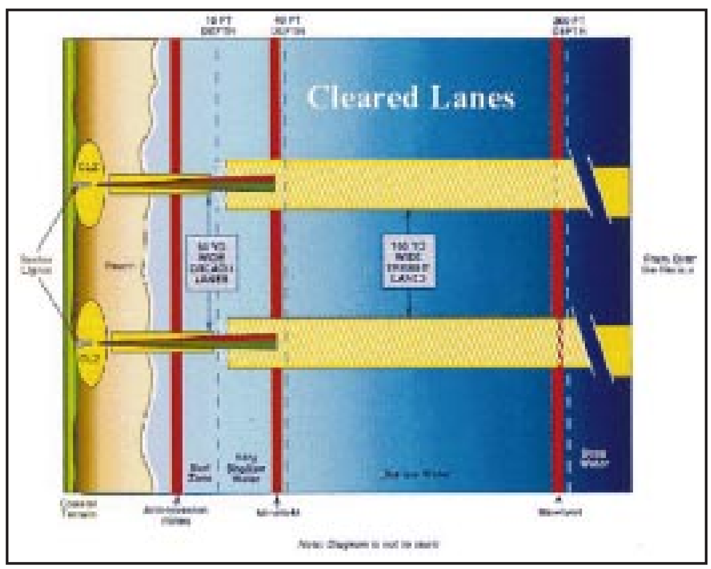
SPONSORS

Navy

IN-STRIDE AMPHIBIOUS BREACHING (G.08)

Background. This DTO demonstrated the accurate deployment of improved explosive neutralization (EN) systems from extended ranges to counter mines in the surf zone and beach zone. It included improved line charges, improved explosive arrays, a Landing Craft Air Cushion (LCAC) fire control system, and deployment of Beach Zone Array from unmanned gliders. The technology objectives of this DTO were met.

Success. The capability demonstrated in the DTO provides the CJTF with a capability to rapidly deploy explosive line charges and arrays to neutralize surf- and beach-zone mines in support of in-stride amphibious assault operations. It includes improved breaching effectiveness, reduced clearance times, significantly increased standoff for breaching platforms, and improved survivability for personnel and equipment. This DTO was demonstrated as part of the Joint Countermine ACTD in June 1998. In the ACTD, it provided fire control/autopilot system on LCAC to perform "dry fire" (or air gun) missions, system performance parameters using system effectiveness model, and inert hardware with containers for logistic handling. The following transitions are being accomplished: automated fire control/extended explosive line charges/arrays transitioned to PMS-407 as a preplanned product improvement (P3I) to Shallow-Water Assault Breaching System (SABRE) and distributed explosive technology (DET), and the deployment system for beach zone explosive array was transitioned to PMS-407 in FY99.

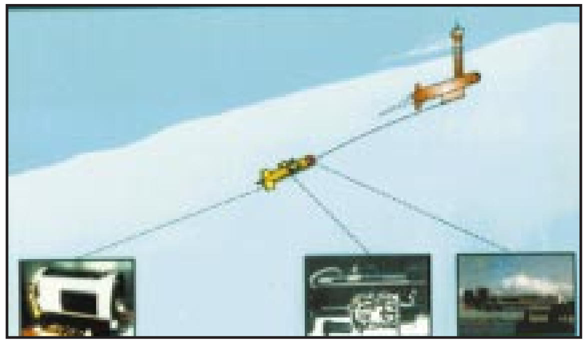


Completed. 1998

SPONSORS

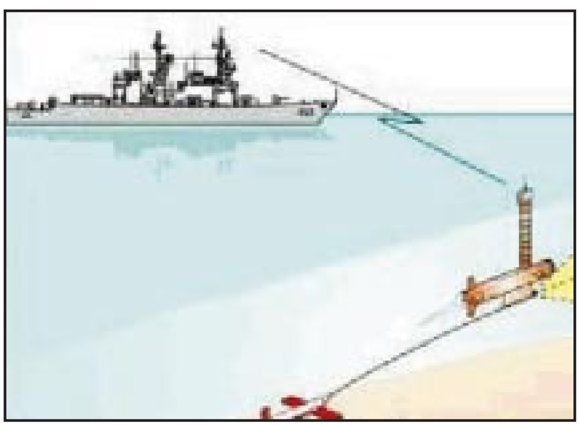
Navy

ADVANCED MINE RECONNAISSANCE/ MINEHUNTING SENSORS (G.09)



Background. This DTO sought to demonstrate underwater sensing and processing technologies for automated mine detection, classification, and data reduction in deep water and littoral environments, and to enable rapid mine reconnaissance and organic minehunting for naval operating areas, sea logistics lanes, and amphibious operating areas. Technical challenges included high-area-coverage operation in deep water; rejection of clutter in the littoral environment; operation of acoustic, EO, and magnetic sensors in very shallow water; acoustic penetration in sediments at low-grazing angles; real-time motion compensation and processing; automated detection and classification of mines; and data fusion of multisensor information. This program successfully demonstrated toroidal volume search sonar, synthetic aperture sonar (SAS), EO imaging, a magnetic gradiometer, and signal and image processing and fusion technologies in a number of operational scenarios.

Success. In Fleet Battle Experiment-E in April 1999, EO and SAS systems 1) quantified sensor suite performance vs. bottom mines and clutter in very shallow water environment, 2) demonstrated re-acquisition and identification of mines detected with the AQS-14 sonar, 3) developed tactics for simultaneous SAS/EO minehunting operations, and 4) employed fleet operators to perform EO operations in real time.



Results from this DTO included transitioned EO identification technology to AN/AQS-14A systems towed from MH-53 helicopters; transitioned mature acoustic and EO technologies to the Remote Minehunting System (V-4), the AQS-20/X, and the Long-term Minehunting Reconnaissance System.

Completed. 1999

SPONSORS

Navy

RAPID FORCE PROJECTION INITIATIVE ACTD (M.05)

Background. The Rapid Force Protection Initiative (RFPI) ACTD was initiated at the request of the U.S. Army to enhance the survivability and lethality of light forces. The desire was to provide the early entry forces with new tactics and equipment that would give them overmatching capabilities against superior forces in the field until they could be reinforced with heavier forces. The ACTD demonstrated a HSOK concept that uses long-range precision sensors, weapon systems, munitions, and digital C2 systems to defeat an enemy armored force and its associated indirect fire systems before it can decisively engage friendly forces. With the HSOK concept, the fight is essentially completed with the fewest possible friendly losses outside direct-fire weapons range. The program was initiated in 1995 and led by the U.S. Army Aviation and Missile Command (AMCOM). AMCOM was supported on the development side by the U.S. Army CECOM and on the operational side by the DBBL. The operational user for this program was the 18th Airborne Corps, with the 101st Air Assault Division as the designated gaining unit.

Success. A brigade of the 101st was able to defeat a reinforced heavy armor division threat in the final demonstration held at Fort Benning in 1998. This was accomplished using the HSOK concept and new equipment, including three new sensor (hunter) systems, three new weapons (killer) systems and a LDTOC. The sensor systems were the HSS, the Remote Sentry (RS) and the Integrated Acoustic System (IAS). The three weapons systems were the Enhanced Fiber Optic Guided Missile (EFOGM), the High Mobility Artillery Rocket System (HIMARS) and an automated 155-mm towed Howitzer. All of these components, as well as the brigade's organic equipment, were tied together by the digital command and control system (LDTOC). Another critical piece of these large-scale demonstrations was a live/virtual simulation system that allowed the exercise to occur at a full scale with terrain larger than Fort Benning and with a full complement of equipment (real or simulated) for both the Red and Blue forces. This simulation was constructed to permit real-on-simulated and simulated-on-real engagements to fully integrate the live and virtual battlespace. It worked flawlessly. For the majority of the demonstration scenarios, the Red forces had 620 armored vehicles and 108 artillery pieces. The Blue forces comprised a Light/Air Assault Brigade with 20 attack helicopters, 29 artillery pieces, other organic equipment, and the RFPI equipment (no tanks). In all cases, the Blue forces won with attrition on the order of 10% or less and the Red forces lost dramatically with attrition on the order of 75% or more. In the post-ACTD period, the Army has chosen to leave the HSS in a residual go-to-war status, to put HIMARS and the automated 155-mm Howitzer into EMD programs and to cancel EFOGM, RS, and IAS.

Completed. 1998

SPONSORS

Army

GUIDED MLRS (M.07)

Background. The Guided Multiple-Launch Rocket System (MLRS) ATD demonstrated a Guidance and Control package integrated with the current MLRS for improved accuracy and reliability. The guidance package was designed to be compatible with various rocket payloads such as bomblets, precision-guided submunitions, mines, and earth penetrator/unitary warheads. Five flight tests were completed which provided data on accuracy and reliability.

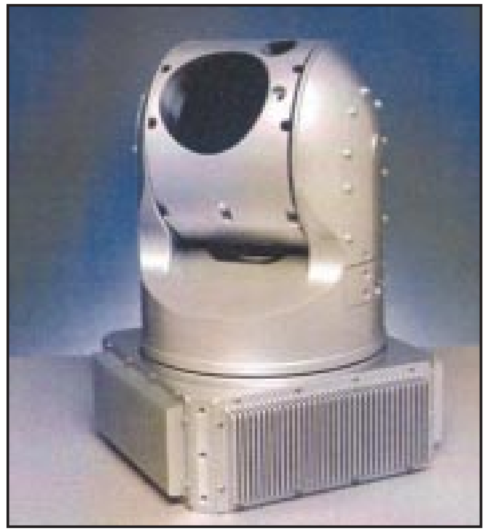
Success. Payoffs include improvements in rocket delivery accuracy to reduce 1) the number of rockets required to defeat the target by as much as sixfold at extended ranges, 2) the required number of launchers per fire mission, 3) the logistical burden, 4) the duration of the fire mission, and 5) possibly, the minimum safe distances to avoid fratricide and collateral damage, as well as an increase in range. System benefits were evaluated through force-on-force modeling, analysis, and simulation. The ATD transitioned to EMD with a contract awarded in November 1998. The EMD will be a cooperative venture with Germany, France, Italy, and the United Kingdom. Production is scheduled to begin in FY01.

Completed. 1998

SPONSORS

Army

MULTISPECTRAL COUNTERMEASURES ATD (H.02)



Background. This project demonstrated advances in laser technology, energy transmission, and jamming techniques for an all-laser solution to Infrared Countermeasures (IRCM) and as a P3I to the Advanced Threat Infrared Countermeasure System (ATIRCM)/Common Missile Warning System (CMWS). These improvements provide the capability to counter both present and future multicolor imaging focal plane array and nonimaging missile seekers.

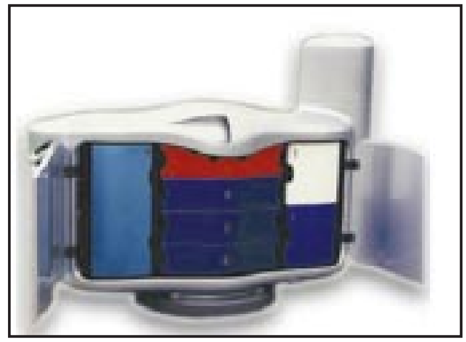
Success. A tunable multiline laser with a fiber optic transmission line, and advanced detection and jamming algorithms were live fire tested using the ATIRCM testbed. The result is a 4x reduction in laser jam head volume, 35 lbs. in weight reduction, a >2x reduction in ATIRCM/CMWS power consumption, and a 6x improvement in jam-to-signal ratio.

Completed.
1999

SPONSORS

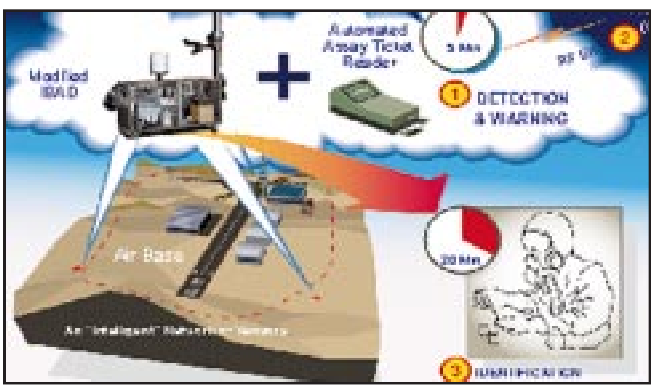
Army

AIRBASE/PORT BIOLOGICAL DETECTION ACTD (I.03)



Background. This DTO developed and demonstrated a biological local warning capability and operational procedures to detect, alarm, warn, dewarn, identify, protect, and decontaminate large areas against a biological warfare (BW) attack on an airbase or port facility. This capability can potentially prevent mass casualties and maintain operational effectiveness at the facility. Along with I.05, this DTO received the David Packard Excellence in Acquisition Award.

Success. This ACTD showed for the first time the capability to detect and protect high-value, fixed-site assets during point and long-line source BW attacks. In FY97, a system was demonstrated that provided rapid detection (5 minutes versus 15 minutes), semiautomated versus manual warning and reporting of a BW attack using RF links, protection (collective protection and commercial oronasal masks), identification (20 minutes versus 30 minutes) and sample handling of eight high-threat agents versus four, and large-area decontamination. This ACTD overcame technical barriers and was able to demonstrate the ability to rapidly identify all BW threat agents. Both a dewarning capability and concepts or capabilities to decontaminate large areas without significant degradation in operational tempo were demonstrated. Deployment of the ACTD sensor network (typically 24 sensors configured to provide coverage of the entire base) began in late 1998 in the Republic of Korea. The prototype system is operational in Southwest Asia.



Completed. 1999

SPONSORS

OSD
DoD Chemical and Biological Defense Program

INTEGRATED BIODETECTION ATD (I.04)

Background. The Integrated Biodetection ATD demonstrated a detect-to-warn capability against biological agents consisting of two components, one that provides a pre-exposure warning for an attack and another that provides an order-of-magnitude increased sensitivity to agents to confirm and identify the agent used. These capabilities were integrated into an overall item identified as the Biological Aerosol Warning System (BAWS).

Success. The BAWS was developed over the four years of this program and consisted of a core set of remotely deployed detectors radio linked to a central receiver/display. Each detector contained aersosol, GPS, wind speed, wind direction, and humidity sensors. The central receiver processed the sensor data, displayed the detectors' locations and status, and produced the alert to the operator if biological agent threshold was exceeded. Field demonstrations highlighted the ability of the system to detect a biological agent attack and track it over the battlespace. This core capability was augmented by a micro ultraviolet-fluorescent, laser-based detection device which added increased sensitivity and reliability. This device was transitioned into the Joint Point Biological Detection System advanced development program. The core BAWS detectors included interfaces to chemical agent alarms and physical sample collectors. In FY98, the ATD developed and demonstrated an automated DNA diagnostic technology to identify biological agents with the highest known degree of reliability and sensitivity. This device, when used in conjunction with the sample collector attached to the remote detectors, was used to confirm an attack and monitor the environment for residual airborne contamination. In FY99, the BAWS was demonstrated as an integrated force protection suite in future battle lab warfighting experiments.

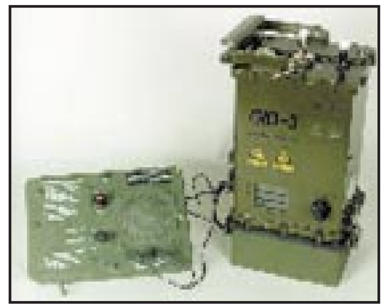
Completed. 1999

SPONSORS

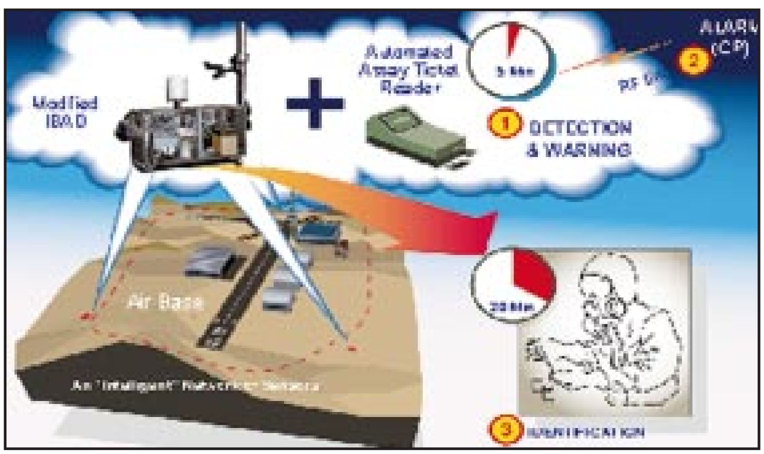
DoD Chemical and Biological Defense Program

CHEMICAL ADD-ON TO AIRBASE/PORT BIOLOGICAL DETECTION ACTD (I.05)

Background. The Chemical Add-On to Airbase/Port Biological Detection ACTD was developed to demonstrate an integrated biological and chemical detection and warning capability at sites within the designated areas of operation associated with the Airbase/Port Biological Detection ACTD (DTO I.03). Along with I.03, this DTO received the David Packard Excellence in Acquisition Award.



Success. The chemical add-on capability used mature and available technology (passive IR spectrometry and ion trap spectroscopy) to automatically detect and identify chemical threat agents in near real time (less than 30 sec). In addition, a JWARN with hardware and software interfaces between three or four different biological, and chemical detectors for the automatic generation of nuclear, biological and chemical (NBC) 1 and 3 reports was demonstrated in FY98. This ACTD developed the concept of operations and doctrine associated with the add-on capability at fixed-site assets. This chemical enhancement ACTD provided the CINCs with a first-time capability to network legacy and emerging biological and chemical detectors and to produce automated warnings and reportings for enhanced battlefield visualization and force protection as defined in Joint Vision 2010.



Completed. 1999

SPONSORS

OSD
DoD Chemical and Biological Defense Program

COUNTERPROLIFERATION I ACTD (J.03)

Background. The Counterproliferation I (CPI) ACTD successfully increased the CINC's counterforce capability to combat the weapons of mass destruction (WMD) threat. This ACTD provided the warfighter with improved planning tools, sensors, and weapons to execute WMD counterforce missions with acceptable and predictable results. This ACTD focused on four major areas: improved target planning and collateral effects tools; improved weapon systems for WMD attack; new sensor systems to aid in target characterization and bomb damage assessment; and a well-defined concept of operations which tied these capabilities together into an effective warfighting capability.

Success. Three operational demonstration and military utility assessment series were conducted during the CPI ACTD. The first demonstrated the new target planning tools to determine the "best" employment of current weapons with a smart fuze against simulated biological agents housed in soft above-ground bermed structures. The second demonstrated current weapons (including cruise missile systems) against a soft, industrial-type chemical production facility. The final demonstration assessed improved capabilities in weapons, sensors, and enhanced planning tools against a simulated, hardened chemical weapons production facility in a shallow-buried, cut-and-cover structure.

In each assessment, with input from the Air Force and Navy operational test communities, the systems were determined to provide a significant enhancement in combat capability. Residual assets were fielded to the operational sponsor to provide an immediate counterforce capability against WMD targets. A subset of the CPI ACTD residuals was requested for Operation Allied Force by Commander 6th Fleet. Afterwards, EUCOM assessed the ACTD and residual deployment as an "unqualified success" and stated that it yielded products employed in Operation Allied Force that, absent the ACTD, could still be in development. Other accomplishments follow.

The Integrated Munitions Effects and Assessments (MEA) Target Planning Tool software was used by all CINCs for Desert Thunder and for Operation Allied Force. The Hard-Target Smart Fuze (HTSF) was certified for carrier operations for Operation Allied Force. The Air Force is procuring 1,000 of this fuzing system, and the Navy is considering its use on the Tactical Tomahawk Penetrator Variant. Eleven Advance Unitary Penetrators (AUP) each of which has more than twice the penetration capability of a BLU-109, was forward deployed during Operation Allied Force, along with 22 HTSFs. The Navy has progammed for production of 450–500 warheads and 500 HTSFs for use on the AUP.

Completed. 1999

SPONSORS

DTRA

APPENDICES

APPENDIX A. CONTACT INFORMATION

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APPENDIX B. LIST OF ONGOING DEFENSE TECHNOLOGY OBJECTIVES*

AIR PLATFORMS

AP.03	Aircraft Support/Sustainment Reduction
AP.06	Helicopter Active Control Technology
AP.07	Demonstration of Advanced Rotor Concepts
AP.08	Fighter/Attack/Strike Propulsion
AP.10	Cruise Missile/Expendable Propulsion
AP.11	Aircraft Power (MEA)
AP.14	Rotary-Wing Vehicle Structures Technology
AP.19	High-Heat-Sink Fuels (JP-900/Endothermic)
AP.20	DARPA Micro Air Vehicles Program
AP.21	Advanced Rotorcraft Technologies

CHEMICAL/BIOLOGICAL DEFENSE

CB.06	Advanced Lightweight Chemical Protection
CB.07	Laser Standoff Chemical Detection Technology
CB.08	Advanced Adsorbents for Protection Applications
CB.09	Enzymatic Decontamination
CB.19	Chemical Imaging Sensor
CB.20	Biological Sample Preparation System for Biological Identification
CB.22	Medical Countermeasures for Vesicant Agents
CB.23	Medical Countermeasures for Staphylococcal Enterotoxin B
CB.24	Medical Countermeasures for Encephalitis Viruses
CB.25	Multiagent Vaccines for Biological Threat Agents
CB.26	Common Diagnostic Systems for Biological Threats and Endemic Infectious Diseases
CB.27	Therapeutics Based on Common Mechanisms of Pathogenesis
CB.28	Chemical Agent Prophylaxes II
CB.29	Reactive Topical Skin Protectant

* The complete descriptions of all ongoing DTOs can be found in the Defense Technology Objectives volume published in February 2000, or on the Defense S&T Planning Website at https://ca.dtic.mil/dstp/. Please note that this website is restricted to .mil or .gov computers, or DoD contractors properly registered with DTIC who have been issued a login name and password.

INFORMATION SYSTEMS TECHNOLOGY

IS.01	Consistent Battlespace Understanding
IS.02	Forecasting, Planning, and Resource Allocation
IS.03	Integrated Force and Execution Management
IS.10	Simulation Interconnection
IS.11	Simulation Information Technologies
IS.12	Simulation Representation
IS.20	Communications Infrastructure Mobility
IS.23	Digital Warfighting Communications
IS.28	Intelligent Information Technology
IS.30	Advanced Embedded Software/System Engineering Technology
IS.32	Information Presentation and Interaction
IS.33	Embedded High-Performance Computing
IS.34	Joint Force Air Component Commander
IS.38	Antenna Technologies
IS.40	Individual Combatant and Small-Unit Operations Simulation
IS.46	Advanced Logistics Project
IS.47	Future Command Post Technologies
IS.48	Agent-Based Systems for Warfighter Support
IS.49	Smart Networked Radio
IS.50	Advanced Intelligence, Surveillance, and Reconnaissance Management
IS.52	Software for Autonomous Systems
IS.53	Deeply Networked Systems
IS.54	Mobile Network Management
IS.55	Information Assurance and Survivability Technology Base
IS.56	Information Assurance and Survivability Systems

GROUND/SEA VEHICLES

GV.01	Future Scout and Cavalry System
GV.03	Ground Vehicle Electronic Systems
GV.04	Advanced Ground Vehicle Mobility Systems

G V.06	Surface Ship Integrated Topside Concepts
G V.07	Surface Ship Advanced Electrical Power System
G V.08	Surface Ship Automation
G V.09	Submarine Advanced Machinery Support System
G V.11	Submarine Electric Drive System
G V.13	Integrated Hit/Kill Avoidance Optimization
G V.14	Reconnaissance, Surveillance, and Targeting Vehicle
G V.15	Tactical Mobile Robotics
G V.16	Combat Hybrid Power Systems

MATERIALS/PROCESSES

M P.01.01	Laser Protection for Personnel and Sensor Systems
M P.02.01	Materials and Processes for Integrated High-Performance Turbine Engine Technology
M P.03.01	Nondestructive Evaluation for System Life
M P.05.01	Protective Materials for Combatant and Combat Systems Against Conventional Weapons
M P.06.01	Computing and Signal Processing Materials for Use in High-Temperature Shock and Radiation Environments
M P.07.01	Materials and Processes for Metal Cleaning, Corrosion Control, and Coatings
M P.07.06	Enhanced Mission Electronics Cost of Ownership
M P.08.06	Affordable Multimissile Manufacturing ATD
M P.13.11	D-Day Fuel Support for Expeditionary Forces ATD
M P.14.11	Wartime Contingencies and Bare Airbase Operations
M P.16.06	Firefighting Capabilities for the Protection of Weapons Systems
M P.17.06	Hazardous and Toxic Waste Treatment/Destruction for DoD Operations
M P.17.11	Airfields and Pavements to Support Force Projection
M P.18.06	Cleanup of Contaminants
M P.24.06	Composite Structures for Missile Defense Systems
M P.25.01	Lean Aircraft Production and Sustainment
M P.26.01	Condition-Based Maintenance/Integrity Monitoring
M P.27.01	Materials for Small-Target Detection Capability in High-Clutter Environments

MP.28.01	Enhanced Coastal Trafficability and Sea State Mitigation for Logistics-Over-the-Shore ATD
MP.29.01	Materials and Processes for Integrated High-Payoff Rocket Propulsion Technology
MP.30.01	Sustainable Military Use and Stewardship of the Environment
MP.32.01	Assured Supply Chain Responsiveness
MP.33.01	Metalworking Affordability Initiative for Castings and Forgings
MP.34.01	Composites Affordability Initiative-Aircraft
MP.35	Smart Materials and Structures for Defense Systems
MP.36	Integrated Survivable Composite Structures
MP.37	Low Observable Materials, Processes, and Maintainability
MP.38	Manufacturing Technology for Infrared Cooled and Uncooled Staring Sensors
MP.39	Combat Equipment Repair Cycle Enhancement
MP.40	Materials and Processes for Affordable, High-Performance Thermal Management
MP.41	Enhanced Detection, Discrimination, and Characterization of Buried Unexploded Ordnance for Environmental Remediation and Active Range Clearance

BIOMEDICAL

MD.01	Sustained Operations Enhancement
MD.02	Vaccines for Prevention of Malaria
MD.03	Far-Forward Hemostasis; Development of Blood Products
MD.06	Prevention of Diarrheal Diseases
MD.08	Laser Bioeffects Countermeasures
MD.11	Far-Treatment of Trauma and Its Sequelae
MD.12	Drugs for Prevention and Treatment of Malaria
MD.18	Medical Countermeasures Against Ionizing Radiation
MD.19	Optimization of Physical Health and Readiness
MD.20	Cytogenic-Based Diagnostic Biodosimetry System
MD.21	Toxicity of Embedded Depleted Uranium
MD.22	Risk Assessment of Combined Exposures to Radiation and Anthrax
MD.23	Radio Frequency Radiation Bioeffects and Countermeasures
MD.24	Intervention for Wellness and Health Promotion

SENSORS, ELECTRONICS, AND ELECTRONIC WARFARE

SE.03	Advanced Radar Processing From Airborne Platforms
SE.05	Automatic Radar Periscope Detection and Discrimination
SE.06	Next-Generation Multifunction Electro-Optical Sensor System
SE.09	Multiwavelength, Multifunction Laser
SE.13	Lightweight, Broadband, Variable-Depth Sonar
SE.14	Multistatic Active Antisubmarine Warfare
SE.15	Affordable High-Performance Towed Arrays
SE.19	Affordable ATR via Rapid Design, Evaluation, and Simulation
SE.20	ATR for Reconnaissance and Surveillance
SE.24	Common Radio Frequency Digital Modules
SE.33	Advanced Focal Plane Array Technology
SE.35	Optical Processing and Interconnects
SE.36	Photonics for Control and Processing of Radio Frequency Signals
SE.37	High-Density, Radiation-Resistant Microelectronics
SE.38	Microelectromechanical Systems
SE.39	Wide-Bandgap Electronic Materials Technology
SE.43	Energy Conversion/Power Generation
SE.44	Power Control and Distribution
SE.57	Analog-to-Digital Converter
SE.58	Lookdown Bistatic Technology
SE.59	Low-Light-Level Imaging Sensors
SE.61	Multiphenomenology Sensor Fusion for ATR and Tracking
SE.62	LADAR ATR for Conventional Weapons
SE.63	Digital Beamforming Antenna Technology
SE.64	Millimeter-Wave Gyro-Amplifiers
SE.65	Long-Wavelength and Multispectral, Large-Area, Staring Focal Plane Arrays
SE.66	Packaging and Interconnect for Multiple Technologies
SE.67	Hyperspectral Applications Technology
SE.69	Autonomous Distributed Sensors
SE.70	Integrated Compact Electronic Sensors for Smart SensorWebs

SE.71	Advanced Multifunction RF System Components
SE.72	Advanced Multifunction RF System
SE.73	E-Scanned Antenna for Airborne Surveillance, Warning, and Control ATD
SE.75	Precision Surveillance and Targeting Radar
SE.77	Infrared Decoy Technology
SE.78	Coherent RF Countermeasures Technology
SE.79	Imaging Infrared Seeker Countermeasures Technology
SE.80	Missile Warning Sensor Technology
SE.81	Network-Centric Electronic Warfare Technology
SE.82	Battlespace Electronic Mapping
SE.83	Multisource Integration and Data Fusion
SE.84	Platform-Independent Open Systems Architectures
SE.85	EO Target Detection, Location, and Noncooperative Identification
SE.86	Adaptive Integrated Optoelectronics for Sensors and Communications
SE.87	Integrated Microfluidic Chips

SPACE PLATFORMS

SP.01	Cryogenic Technologies
SP.03	Space Structures and Control
SP.05	Large, Precise Structures
SP.08	Space Power System Technologies
SP.10	Liquid Boost Propulsion/IHPRPT Phase I
SP.11	Orbit Transfer Propulsion
SP.20	Spacecraft Propulsion/IHPRPT Phase I
SP.22	Advanced Cryogenic Technologies

HUMAN SYSTEMS

HS.01	Advanced Aircrew Escape
HS.04	Knowledge Representation Technologies for Human Performance Enhancement
HS.05	Ballistic Protection for Improved Individual Survivability
HS.06	Joint Cognitive Systems for Battlespace Dominance
HS.07	Crewstation Integration Demonstrations

HS.08	Crew System Engineering Design Tools
HS.11	Force XXI Training Strategies
HS.12	Helmet-Mounted Sensory Ensemble
HS.13	Human-Centered Automation Testbed
HS.15	Integrated Personnel Management Technologies
HS.17	Panoramic Night Vision Goggle Technology
HS.21	Decision Support Systems for Command and Control
HS.22	Cogeneration for Field Services
HS.23	Immersive Interfaces and Visualization Techniques for Controlling Unmanned Vehicles
HS.24	Deployable Sonar Training Technology
HS.25	Multifunction Fabric System
HS.26	Smart Aircrew Integrated Life Support System
HS.27	Night Vision Device Training Research
HS.28	Distributed Mission Warfighting Training Techniques and Technologies
HS.29	Maximizing 21st-Century Noncommissioned Officer Performance
HS.30	Realistic Cognitive and Behavioral Representations in Simulation
HS.31	Combat Rations for Enhanced Warfighter Logistics

WEAPONS

WE.10	Integrated Beam Control for Ground-Based Laser Antisatellite System
WE.13	Counteractive Protection Systems
WE.18	Direct Fire Lethality ATD
WE.21	Fiber-Optic, Gyro-Based Navigation Systems
WE.22	High-Power Microwave C2W/IW Technology
WE.29	Antitorpedo Torpedo ATD
WE.32	Broadband Torpedo Sonar Demonstration
WE.33	Electrothermal-Chemical Armaments for Direct Fire
WE.34	Objective Crew-Served Weapon ATD
WE.35	Air Superiority Missile Technology
WE.39	Tactical Missile Propulsion

WE.41	Multimission Space-Based Laser
WE.42	Laser Aircraft Self-Protection Missile Countermeasures
WE.43	Advanced Multiband Infrared Countermeasures Laser Source Solution Technology
WE.45	Sea Mines
WE.50	Compact Kinetic Energy Missile Technology
WE.52	Best Buy ATD
WE.54	Reactive Material Warhead ATD
WE.55	Reduced-Size Torpedo Subsystem Demonstration
WE.57	Lethality/Vulnerability Models for High-Value Fixed Targets
WE.58	Microelectromechanical Sensor Inertial Navigation System
WE.60	High-Power Microwave Munitions
WE.61	Modernized Hellfire Guidance and Control/Seeker Technology Effort
WE.62	High-Quality Antimateriel Submunition Program
WE.63	Direct-Attack Munition Affordable Seeker ATD
WE.64	Advanced Light Armament for Combat Vehicles
WE.65	High-Efficiency, Scalable Solid-State Lasers for Military Applications

NUCLEAR TECHNOLOGY

NT.01	Nuclear Operability and Survivability Testing Technologies
NT.02	Electronic System Radiation Hardening
NT.03	Hard-Target Defeat
NT.04	Prediction and Mitigation of Collateral Hazards
NT.05	Balanced Electromagnetic Hardening Technology
NT.06	Survivability Assessments Technology
NT.07	Integrated Comprehensive Weaponeering Capability
NT.08	Nuclear Weapon Safety and Reliability
NT.09	Nuclear Phenomenology

BATTLESPACE ENVIRONMENTS

BE.01	Forecast of Littoral Currents and Waves
BE.02	Autonomous Ocean Sampling Network: Mapping of Ocean Fields
BE.03	Weather/Atmospheric Impacts on Sensor Systems

BE.04	On-Scene Weather Sensing and Prediction Capability
BE.06	Satellite Infrared Surveillance Systems Backgrounds
BE.08	Rapid Mapping Technology

INFORMATION SUPERIORITY

A.02	Robust Tactical/Mobile Networking
A.05	Integrated Collection Management ACTD
A.06	Rapid Terrain Visualization ACTD
A.11	Counter-Camouflage Concealment and Deception ATD
A.12	Information Dominance (C2 Protect and Attack for I/O ATD)
A.13	Satellite C3I/Navigation Signals Propagation Technology
A.23	C4I for Coalition Warfare ACTD
A.25	Information Operations Planning Tool ACTD
A.26	Information Assurance: Automated Intrusion Detection Environment ACTD
A.27	Global Precision Surveillance: Discoverer II
A.28	Space-Based Space Surveillance Operations ACTD
A.30	Personnel Recovery Mission Software ACTD
A.31	Human Intelligence and Counterintelligence Support Tools ACTD
A.32	CINC 21 ACTD
A.33	Communications/Navigation Outage Forecasting System ACTD
A.34	Content-Based Information Security ACTD
A.35	Joint Intelligence, Surveillance, and Reconnaissance ACTD
A.36	Multiple Link Antenna System ACTD
A.37	Tri-Band Antenna Signal Converter ACTD

PRECISION FIRES

B.06	Air/Land Enhanced Reconnaissance and Targeting ATD
B.07	Joint Continuous Strike Environment ACTD
B.15	Powered Low-Cost Autonomous Attack System Program
B.16	Concentric Canister Launcher
B.18	Low-Cost Precision Kill ATD
B.19	Cruise Missile Real-Time Retargeting

B.21	Miniaturized Munition Technology Guided Flight Tests
B.24	Programmable Integrated Ordnance Suite
B.25	Theater Precision Strike Operations ACTD
B.26	Multifunction Staring Sensor Suite ATD
B.27	Point-Hit ATACMS/MLRS
B.29	Battle Damage Assessment in the Joint Targeting Toolbox ACTD
B.30	Affordable, Moving Surface Target Engagement
B.31	Coalition Aerial Surveillance and Reconnaissance ACTD
B.32	Quick Bolt ACTD
B.33	Computerized Operational MASINT Weather ACTD

COMBAT IDENTIFICATION

C.04	Advanced Air and Surface Target Identification ATD
C.05	Precision Targeting Identification ACTD
C.07	Link-16 ACTD
C.08	Advanced Combat Identification Capability
C.09	Advanced Cooperative Air Target Identification (Mode 5)

JOINT THEATER MISSILE DEFENSE

D.03	Discriminating Interceptor Technology Program
D.05	Advanced Space Surveillance
D.08	Atmospheric Interceptor Technology
D.10	Airborne Laser Technology for Theater Missile Defense
D.11	Ground-toAir Passive Surveillance ACTD

MILITARY OPERATIONS IN URBANIZED TERRAIN

E.01	Small-Unit Operations TD
E.02	Military Operations in Urbanized Terrain ACTD
E.04	Joint Nonlethal Weapons

JOINT READINESS AND LOGISTICS AND SUSTAINMENT OF STRATEGIC SYSTEMS

F.17	Advanced Amphibious Logistics and Seabasing for Expeditionary Force Operations ATD

F.18	Joint Advanced Health and Usage Monitoring System ACTD
F.19	Joint Logistics ACTD
F.23	Modular Aircraft Support System
F.24	Adaptive Course of Action ACTD
F.25	Coherent Analytical Computing Environment ACTD
F.27	Joint Medical Operations-Telemedicine ACTD
F.28	Joint Theater Logistics ACTD
F.29	Small-Unit Logistics ACTD

FORCE PROJECTION/DOMINANT MANEUVER

K.01	Post-Boost Control System Technology
K.02	Missile Flight Science
K.03	Aging and Surveillance Technology
K.04	Underwater Launch Technology
K.05	Submarine Navigation Technology
K.06	Missile Propulsion Technology
G.01	Mine Hunter/Killer ATD
G.06	Rapid Airborne Mine Clearance System ATD
G.11	Advanced Mine Detection Sensors
G.12	Lightweight Airborne Multispectral Countermine Detection System
G.13	Electro-Optic Mine Identification
G.14	Automatic/Aided Technology for Detection of Unexploded Ordnance Clearance ATD
G.15	Very Shallow Water Reconnaissance/Clearance
M.01	Offboard Augmented Theater Surveillance ATD
M.02	Extending the Littoral Battlespace ACTD
M.04	Line-of-Sight Antitank System ACTD
M.06	Precision-Guided Mortar Munition ATD
M.09	High-Mobility Artillery Rocket System
M.10	Theater Air and Missile Defense Interoperability ACTD
M.11	Common Spectral MASINT Exploitation ACTD
M.12	Load Carriage Optimization for Enhanced Warfighter Performance

M.13	Hypersonic Weapons Technology Demonstration
M.14	Artillery-Launched Observer Round ATD
M.15	Future Combat System

ELECTRONIC WARFARE

H.04	Miniature Air-Launched Decoy Program ACTD
H.05	Large-Aircraft Infrared Countermeasures ATD
H.07	Enhanced Situation Awareness Demonstrations
H.08	Onboard Electronic Countermeasures Upgrade ATD
H.10	Precision EW Situation Awareness, Targeting, and SEAD Demonstrations
H.12	Modular Directed Infrared Countermeasures

CHEMICAL/BIOLOGICAL WARFARE DEFENSE AND PROTECTION AND COUNTER WEAPONS OF MASS DESTRUCTION

I.02	Joint Biological Remote Early Warning System ACTD
I.03	Restoration of Operations ACTD
J.04	Counterproliferation II ACTD

COMBATING TERRORISM

L.01	Vehicle Entry Point Screening
L.03	National Infrastructure Protection
L.04	Standoff Detection of Nitrogen-Based Explosives
L.05	Diagnostic Analysis of Improvised Explosive Devices
L.06	Mitigation of Terrorist Attacks on Key Facilities
L.07	Terrorist Chemical/Biological Countermeasures
L.12	Force Medical Protection/Dosimeter ACTD
L.13	Migration of Defense Intelligence Threat Data System ACTD

PROTECTION OF SPACE ASSETS

N.01	Space Radiation Mitigation for Satellite Operations
N.02	Compact Environmental Anomaly Sensor II ACTD
N.03	Space Environments and Hazards
N.04	Satellite Passive Protection
N.05	Global Monitoring of ISR Space Systems ACTD

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

ACBL	Amphibious Cargo Beaching Lighter
ACTD	Advanced Concept Technology Demonstration
ADOCS	Advanced Deep Operations Coordination Systems
AFOTEC-TA	Air Force Operational Test and Evaluation Center
AFRL	Air Force Research Laboratory
AFSOC	Air Force Special Operations Component
A-G	air-ground
AGTFT	Antijam GPS Technology Flight Test
AHOS-M	Advanced Hybrid Oxygen System-Medical
AHP	Advanced Helicopter Pilotage
ALISS	Advanced Lightweight Influence Sweep System
AMRAAM	advanced medium-range air-to-air missile
AMSAA	Army Materiel Systems Analysis Activity
AMT	accelerated mission test
ANG	Air National Guard
ARGUS	Advanced Remote Unattended Ground Sensor
ART II	Advanced Rotorcraft Transmission II
ASBREM	Armed Services Biomedical Research Evaluation and Management
ATD	Advanced Technology Demonstration
ATD/C	automatic target detection/cueing
ATG	air-to-ground
ATIRCM	advanced threat infared countermeasure system
ATR	automatic target recognition
Auto-GCAS	Autonomous Ground Collision Avoidance System
BAWS	Biological Aerosol Warning System
BCIS	Battlefield Combat Identification System
BCID	Battlefield Combat Identification
BDA	battle damage assessment
BFTT	Battle Force Tactical Training
BMDO	Ballistic Missile Defense Organization
BW	biological warfare
C2TD	command and control technology demonstration
C2ISR	command, control, intelligence, surveillance and reconnaissance
C4I2	command, control, communications, computers, information, intelligence
CAS	close air support
CAESAR	Component and Structural Assessment Research
CAV ATD	Composite Armored Vehicle Advanced Technology Demonstrator

CB	chemical/biological
CCD	charged coupled device
CECOM-RDEC	Communications Electronics Command- Research, Development and Engineering Center
CENTCOM	Central Command
CFD	computational fluid dynamics
CI	combat identification
CID	joint combat identification
CIDDS	Combat ID Dismounted Soldier
CINC	Commander(s) in Chief
CJTF	Commander, Joint Task Force
CLAS	Conformal Loadbearing Antenna Structures
CMWS	Common Missile Warning System
COBRA	Coastal Battlefield Reconnaissance and Analysis
CONOPS	concept of operations
CORBA	common object request broker architecture
COTS	commercial off-the-shelf
CPI	Counterproliferation I
CW	conventional weapons; or continuous wave
DARPA	Defense Advanced Research Projects Agency
DBBL	Dismounted Battle Space Battle Lab
DET	distributed explosive technology
DEW	directed energy weapons
DII/COE	Defense Information Infrastructure/Common Operating Environment
DI&S	Design Integration and Supportability
DMT	distributed mission training
DTAP	Defense Technology Area Plan
DTO	Defense Technology Objectives
DTRA	Defense Threat Reduction Agency
DV	demonstration/validation
EFOGM	enhanced fiber optic guided missile
EM	electromagnetic
EMD	engineering and manufacturing development
EN	explosive neutralization
EO	electro-optic imaging
EW	electronic warfare
FLIR	forward looking infrared

FM3TR	Future Multiband Multiwaveform Modular Tactical Radio
FMTI	Future Missile Technology Integration
FOPEN	foliage penetration radar
FORSCOM	United States Army Forces Command
FOV	field of view
FTV	flight test vehicles
FWA	Future Warrior Architecture
GCCS	Global Command and Control System
GOTS	government off-the-shelf
GPS	Global Positioning System
GVW	ground vehicle weights
HEPA	high-efficiency particulate aerosol
HIMARS	High Mobility Artillery Rocket System
HMD	helmet mounted display
HP	high performance
HPF	high performance Fortran
HPT	hazard prediction tool
HSOK	hunter/standoff killer
HSS	Hunter Sensor Suite
HTSF	Hard-Target Smart Fuze
IA	image analyst
IAS	Integrated Acoustic System
ICBM	intercontinental ballistic missile
IFOGs	interferometric fiber optic gyros
IFP	Image Formation Processing
IHPTET	Integrated High-Performance Turbine Engine Technology
IIR	imaging infrared
IMAT	Interactive Multisensor Analysis Training Technology
IMEA	integrated munitions effects assessment
IMU	inertial measurement unit
IR	infrared
IRCCM	infrared counter-counter measures
IRCM	infrared countermeasures
IRFPA	infrared focal plane array
IRST	Infrared Search and Track Systems
IST	Information Systems Technology
JBC	Joint Battle Center

JC2WC	Joint Command and Control Warfare Center
JCIDO	Joint Combat Identification Office
JCM	Joint Countermine
JDAM	joint direct attack munitions
JFCOM	Joint Forces Command
JITC	Joint Interoperability Test Command
JLOTS	Joint Logistics Over the Shore
JPO	Joint Projects Office
JRAMS	Joint Readiness Automated Management System
JSGPM	joint service general-purpose mask
JTF-ATD	Joint Task Force-Advanced Technical Demonstration
JTRS	joint tactical radio system
JWARN	Joint Warning and Reporting Network
JWCO	Joint Warfighting Capability Objective
JWSTP	Joint Warfighting Science and Technology Plan
LCAC	landing craft air cushion
LDTOC	Light Digital Tactical Operation Center
LOGCAT	Logistics Capability Assessment Tool
LOX	liquid oxygen
LRIP	limited-rate initial production
LW	Land Warrior
M&P	Materials and Process
M&S	modeling and simulation
MAGI	an AF particle hydrodynamics code
MAJCOM	Major Command
MARCORSYSCOM	Marine Corps Systems Command
MASINT	measurement and signature intelligence
MESFET	Metal-semiconductor field-effect transistor
MFLS	Multifunction Laser System
MICOM (MOS)	United States Army Missile Command
MILES	Multiple Integrated Laser Engagement System
MLRS	Multiple-Launch Rocket System
MMPM	millimeter-wave power module
MNS	Mission needs statement
MSOGS	Molecular Sieve Oxygen Generation Systems

MTC	Mission Training Center
NAS	numerical aeronautical simulation
NAVSPACOM	Naval Space Command
NAVWAR	navigation warfare
NBC	nuclear, biological, and chemical
NGII	Next Generation Information Infrastructure
NRE	non-recurring engineering
NVESD	Night Vision and Electronic Sensors Directorate
ODUSD	Office of the Deputy Under Secretary of Defense
ONR	Office of Naval Research
ORD	operational requirements document
PEEK	polyetheretheretone
PM	program manager
PMC4I	Program Manager-Command, Control, Communications, Computers and Intelligence
PM-NV/RSTA	Program Manager-Night Vision/Reconnaissance, Surveillance and Target Acquisition
P/RCMRL	Precision Rapid Counter-Multiple Rocket Launcher
PRSF	
PSTS	Precision Signals Intelligence Targeting System
RADCON	Radiation Control
RCS	radar cross sections
RF	radio frequency
RFPI	Rapid Force Projection Initiative
RMWS	Remote Miniature Weather Station
RPA	Rotorcraft Pilot's Associate
RS	remote sentry
SA	situational awareness
SABRE	Shallow-Water Assault Breaching System
SADL	Situational Awareness Data Link
SAIP	semiautomated imagery process
SAR	synthetic aperture radar
SAS	synthetic aperture sonar
SCUD	Surface-to-Surface Missile System
SEAD	suppression of enemy air defenses
SEEW	sensors, electronics, and electronic warfare
SEP	Sensor Emulation Platform

SFE	Synthetic Forces Express
SiC	silicon carbide
SIGINT	signals intelligence
SINCGARS SIP	Single Channel Ground and Airborne Radio System-System Improvement Plus
SOCOM	Special Operations Command
SPO	System Program Office
SS3	sea state 3
SSP	Strategic Systems Program
STO	Science and Technology Objective
STOW	Synthetic Theater of War
SWAT	Subjective Workload Assessment Technique
TA	target acquisition
TAC	Total accumulated cycles
TARA	Technology Area Review and Assessment
TEXCOM	Test and Experimentation Command
TI	target identification
TLE	Target Location Error
TMD	theater missile defense
TOC	tactical operations center
TOE	Table of Organization and Equipment
TPIO	Training and Doctrine Command Program Integration Office
TRAC-WSMR	Training and Doctrine Command Requirements Analysis Center-White Sand Missile Range
TRADOC	United States Army Training and Doctrine Command
TRL	technology readiness level
TTP	tactics, techniques, and procedures
UAV	unmanned aerial vehicle
UCAV	unmanned combat air vehicle
UGS	unattended ground sensors
UMS	unattended MASINT sensor
USACOM	United States Atlantic Command
USW	undersea warfare
WAMS	wide-area munitions
WMD	weapons of mass destruction